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This sectional view, taken at the new City Hall station, shows the construction of the subways by the "cut-and-cover" method, by which the material is excavated without any disturbance of the surface of the streets and sidewalks.

BUILDING THE FOUR-TRACK SUBWAY BENEATH BROADWAY, NEW YORK.—[See page 154.]

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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

The purpose of this journal is to record accurately, simply, and interestingly, the world's progress in scientific knowledge and industrial achievement.

A Foolish Measure

IT is simply amazing to learn that a bill has been introduced into the House of Representatives seeking for Government aid in the preliminary work of building a dam or jetty, from 250 to 500 feet in depth and 200 miles long, reaching out into the broad Atlantic from the coast of Newfoundland. Of all the foolish bills that have found their way into the halls of Congress, surely this is the most conspicuous. It is the modest purpose of the promoter of this most modest proposal to divert the Gulf Stream, and thereby bring about sweeping climatic changes in the United States, in Greenland, and over various widely scattered areas of the habitable and uninhabitable globe.

We have been asked to comment on this bill, and we do so.

The SCIENTIFIC AMERICAN expresses the hope that, in the consideration of the scheme, the gift of imagination will be so mercifully tempered by the saving grace of humor, that the measure will be given an early burial, with such obsequies as, in the opinion of the House, are becoming to its dignity and importance.

New York Pier Problem Settled

IN a characteristically clear and forceful decision, Secretary of War Stimson has effected a compromise between the interests of the Port of New York and the interests of the nation at large, which must be considered as a very satisfactory solution of a pressing problem. The city of New York had asked permission of the War Department to locate its new pierhead line, so that it would run in a direct line from Thirtieth Street to Pier No. 1 at the Battery. This would have involved a considerable lengthening of the new Chelsea piers which are located at the narrowest part of the river. The War Department took the position, and indeed has held it for several years, that no further encroachment upon the fairway at its narrowest point could be allowed. Under Secretary Stimson's decision, the pierhead line at Chelsea is to remain where it is; but the city is permitted to straighten its pierhead line between Gansevoort Street and Pier No. 1. This will make it possible to build a dozen or fifteen piers of a length of one thousand feet—sufficient to provide for the growth of ocean steamships for many years to come. Also, the Secretary has given permission to straighten out the pierhead line on the New Jersey side of the river, between the Morris Canal Basin and the foot of Fifth Street, Hoboken, a section lying south of the Chelsea reach. This will give similar and even more generous accommodation for the future growth of steamships of the German companies.

As to the more remote future, the Secretary refers to the plan of the Board of Estimate and Apportionment, which contemplates the construction of long piers between Forty-fourth and Fifty-sixth streets, within the existing pierhead lines. This plan is designed to secure the desired length by excavating back into Manhattan. The construction of such piers will be costly; and in view of the constantly increasing value of land, we would suggest that it would be good policy for the city to purchase, at once, all the land lying between these streets and extending back as far as Eleventh Avenue. This would provide sufficient depth from the pierhead line for piers of a length up to 1,500 feet, and it would also accommodate the marginal terminal railway contemplated by the present Dock Commissioner.

The Problem of the Mississippi River

THE great flood of the Mississippi River of last year—the largest in recorded history—when the levees were over-topped or carried away bodily, and vast areas of the valley were inundated, has created a doubt in the minds of the public as to whether the method of control by revetment and construction of levees was not a failure. This doubt has been freely expressed in the many letters which have been published, during the past year, in the columns of the SCIENTIFIC AMERICAN. We have made no comment upon these letters, many of which suggested alternative and supposedly better plans for the control of the river, and our silence has been due to the fact that we were making a study of the problem from every possible source of information, with a view to determining for ourselves whether the present plans for the control of the river, or some other, were the best to apply in grappling with and controlling this stupendous problem.

We have come to the conclusion that the present plan of the army engineers of protecting the banks of the river by revetment and raising the banks by artificial levees to a sufficient height to prevent overflow, is not only the best way to control the river, but the only way.

If it be asked whether the disastrous inundation of last year does not spell failure, we answer emphatically No. The inundation occurred, not because the plan was faulty, but because it was incomplete. It was also due to the fact that the existing levees were built only to a sufficient elevation to control the highest flood on record, which the flood of last year greatly exceeded —the maximum flow reaching the enormous total of 2,300,000 feet per second, or twelve times the amount of water that passes over Niagara Falls.

The trouble with the Mississippi work is not that the plans are wrong, but that they have been carried out piecemeal, and in a somewhat happy-go-lucky manner. The nation should apply to this great work the lesson which it has learned at Panama. A new grade line for the summit of the levees should be established, said line being well above the height reached by the flood of last year; a liberal estimate should be made of the total cost of building these levees, and of protecting the adjacent banks of the river throughout the whole length of the levees with revetments; an estimate should be made of the largest annual appropriation of money that could be efficiently expended by the largest force that could be concentrated upon the work; and finally the execution of the work should be placed entirely in the hands of the army engineers with a Col. Goethals in supreme and unhampered control.

Such an estimate of the total cost of a completely leveed and revetted Mississippi River has been made by the army engineers under the Mississippi River Commission. The total expenditure would be about seventy million dollars for the levee work and about ninety million dollars for the revetment.

Is complete control of the Mississippi River and the absolute prevention of disastrous floods worth the expenditure of one hundred and sixty million dollars? The SCIENTIFIC AMERICAN is decidedly of the opinion that the money would be well spent. In the first place, the completion of this work would afford protection to 29,000 square miles of land. The increased value of the land, due to protection, is shown by a statement of Col. Townsend, president of the Mississippi River Commission, who has recently testified before the Committee on Rivers and Harbors in the House of Representatives that twenty years ago, when he was first stationed in the St. Francis Basin, land in that vicinity could be bought for a dollar or two an acre, whereas to-day it is worth anywhere from twenty to fifty dollars and even one hundred dollars an acre. Furthermore, there is the humanitarian consideration that this work would prevent the great loss of life and destruction of property which occurs when the river breaks loose. And finally there is the consideration that the completion of this task will constitute a great national work of engineering comparable, in its magnitude and beneficent results, with the execution of the Panama Canal.

We will now proceed to discuss the criticisms of the present plan, and the suggestions of alternative schemes of control, which have been made in the many letters referred to above. It has been stated that the whole principle of levee building is wrong; and this for the reason that the matter brought down in suspension is deposited along the bed of the river, which is continually being raised, that this necessitates a raising of the levees which must go on indefinitely. As a matter of fact, what takes place is this: when the floods come down, the deep pools are scoured out and the material is deposited on the shoals farther down the river, causing a temporary raising of the bottom at these points. As the river falls, the action is reversed, the bars are scoured out and the sand is deposited in the next pool. Careful surveys for several decades show that not only has there been no raising of the river bed, but the cross-section of the river has slightly increased.

As to the proposal to control the Mississippi by building vast reservoirs near the head waters of the river and its tributaries, it may be said at once that the magnitude and cost of such reservoirs and the enormous areas of land that would have to be condemned, render such a scheme impracticable. Its advocates have failed to realize the stupendous magnitude of a problem which involves the control of flood waters that sweep down the Mississippi River at the rate of 2,300,000,000 cubic feet *per second*. Testifying on the point, Col. Townsend said before the House Committee: "If you were to destroy the whole State of Minnesota, that is, stop every bit of water flowing over it, it would not have made a difference of three tenths of a foot in the height of the last flood at Cairo." Again, if, as has been suggested, the St. Francis Basin were converted into a storage reservoir, and the floods were thereby reduced three or four feet in height, it would be necessary to sacrifice no less than seven thousand square miles of country, or the area of a good-sized State.

Another favorite scheme contemplates the diversion of the Mississippi, or of a large portion of its flood waters, by means of sub-channels, or "canals," excavated on one side or the other of the river. This suggestion also fails to appreciate the magnitude of the problem. If such channels were to be cut, they would have to be leveed in exactly the same way as the river which they were intended to relieve. To produce any serious diminution in the height of a river that was passing down 2,300,000,000 cubic feet of water per second, it would be necessary to divert from 400,000 to 600,000 feet per second; which means that an artificial river would have to be excavated and leveed whose flow would be from two to three times as great as the whole flow of the Niagara River.

The proposition to straighten out the river by cutting through the bends is impracticable for the reason that while the more rapid flow would relieve the flood, in the districts thus affected, this relief would be obtained at the expense of the districts lower down the river. The swifter current of the flood water, due to the shorter course, would necessitate a corresponding increase in the height of the levees in the lower sections of the valley.

As to the important question of financing the work, the simplest and most effective plan, of course, would be to do with regard to the Mississippi as we have done at Panama: make it a national problem and provide the whole cost from the national treasury. Hitherto the Government has put up so much money; so much has been contributed by the local levee boards; and in one case, at least, the State has made appropriations. It is not surprising to learn that Col. Townsend designates such conditions as amounting to practically "an absence of system." Says he: "We have just simply been waiting, each one doing the best he could—the levee boards have been doing their work, and the district engineers have been doing whatever they could with their funds, and it has been a happy-go-lucky method of business."

We believe that the most satisfactory way of financing the project would be for Congress to treat the improvement of America's greatest river as a national undertaking; make the necessary appropriations; abolish the system of individual boards and place the execution of the work under the one-man control of the army. Next to this the best plan would be one of joint Federal and State appropriations, in proportions to be determined by the local advantages secured; with the physical design and execution of the work intrusted to the Corps of Engineers of the Army, working under the absolute control of a army officer of proved executive ability.

In another year the Panama Canal will be completed. Why not move Col. Goethals with his admirable staff and perfectly working system from the Isthmus of Panama to the Mississippi Valley?

Meteorology in the Far East

AT the suggestion of Prof. Nakamura, in charge of the meteorological service of Japan, there will soon be held a meeting of the directors of meteorological observatories in the Far East—the first assembly of its kind. Practical meteorology has made great progress in that part of the world in recent years. Notable steps have been the extension of the Philippine Weather Bureau to outlying islands favorably situated for keeping track of typhoons; the organization of a complete meteorological service in Indo-China; the establishment of a telegraphic weather service along the whole China coast, and to a rapidly growing extent in the interior of China, under the Zikawei Observatory, at Shanghai; the creation by the Germans of a local service for Kiao-chau, with headquarters at Tsingtao; and the organization of an excellent service in Korea, under Japanese auspices. It is understood that China intends to establish a national weather service, with headquarters at Peking, but no details of this plan are yet known.

Engineering

Battleship Costs and the Eight-hour Law.—The Chief of the Bureau of Construction and Repair, Rear-Admiral R. A. Watt, states in his report that the average price per ton of normal displacement of the "Texas," "Nevada," and "Oklahoma," which are being built under contract under the eight-hour law, is $215.26. The average price of the three preceding battleships, built by contract when the hours of labor were unrestricted, was $177.05 per ton of normal displacement, and for the five preceding vessels it was $189.99 per ton.

Prosperity in British Shipbuilding.—Just now the British shipbuilding yards are experiencing an extraordinary run of prosperity. The total tonnage of all ships under construction for merchant and navy service reaches the huge total of 2,466,940 tons, of which about 500,000 tons consists of warships for the British and other navies. In 1909, a period of depression, 764,520 tons of merchant ships was built, or rather was under construction. To-day there is under construction 1,970,065 tons of merchant ships.

To Dock the Largest Liners.—The city of Boston is to be congratulated on its enterprise in appropriating $3,000,000 for the construction of a drydock capable of taking the largest ocean liners. The construction of such a dock at New York has been the subject of much talk but little action. A 1,000 foot dock is liable to be at any time most urgently needed. Had the "Titanic" been able to crawl into New York harbor, she might have had to stay here indefinitely; for there is not a dock in the country that could accommodate her.

Surprise Signals for Locomotive Engineers.—In view of the many accidents on the New York, New Haven & Hartford Railroad, due to engineers running by signals, the company has ordered a series of test surprise signals. According to a dispatch from New Haven, the tests will include improper train orders, displaced switches and a number of changes of signals. Tests of this character act as a strong inducement to strict watchfulness and obedience on the part of trainmen generally. The practice is followed on several roads, we understand, with excellent results.

Perkin Medal for James Gayley.—The Perkin Gold Medal was recently awarded to James Gayley, formerly first vice-president of the United States Steel Corporation. Gayley is the seventh recipient of the medal, which was created in honor of Sir William Henry Perkin, the founder of coal tar chemistry, which revolutionized the dye and drug industry. The medal was awarded to Mr. Gayley for his invention of the dry-air blast for the manufacture of iron. This invention brought about a reduction of at least $1 a ton in the cost of producing pig iron, besides making it possible for the iron master to produce in all weathers a product of uniform quality.

The Selection of Locomotives.—In the paper before the American Society of Mechanical Engineers in this city, Mr. O. F. Beyer, Jr., speaking on the question of the selection of locomotives in relation to the economics of railway operation, stated that the main steps in this selection may be divided into: The consideration of the service; the nature of the business; the topography of the road, train speed, and train resistance; types and sizes of locomotives available; improvements to the permanent plant; effects of various types and sizes of locomotives on operating expenses; and the final selection of the most economical type and size of locomotive.

Length of Piers at New York.—On May 14th the world's largest steamship, the "Imperator," is due at this port. She is 919 feet long. The longest permanent piers on the Manhattan side of the Hudson River are 825 feet long; and these are leased by the Cunard Company. The White Star Company dock the "Olympic" at an 800-foot pier, which has been temporarily lengthened to 900 feet; but the extension must ultimately be removed. On the Jersey side the North German Lloyd has a 900-foot pier. The Hamburg-American Line, owners of the "Imperator," have an 850-foot pier. To dock the big ship this pier will be lengthened to 950 feet. Secretary Stimson's recent decision provides for 1,000-foot piers.

Cuniberti on Battleship Protection.—At a recent meeting of the Corps of Italian Naval Architects, Major-General Cuniberti doubted whether the means of defense of modern battleships of the dreadnought type had progressed proportionally to the increase in their offensive power. He considers that a naval battle at ten thousand yards would demonstrate that gun-power was "vastly superior to the resistance of the armor protecting the ship attacked." He would concentrate the protection; but he realizes the difficulty of determining exactly which sections of the ship should be more adequately defended. Very interesting to us is his statement that the dreadnoughts of almost all the navies, except perhaps those of the United States, are very deficient in regard to protection. Undoubtedly Cuniberti had in mind those two heavily protected ships, the "Nevada" and "Oklahoma," which we consider to be by far the most efficient all-round fighting units to be found in any navy to-day.

Electricity

Electric Trucks in Boston.—In 1902 the first electrically-driven delivery wagons were introduced in Boston. There were only two cars that year; in 1905 the number had increased to ten; in 1910 there were 119 electric trucks; and in 1912, 279, an increase in the last two years of 134 per cent.

Electrification of a Rocky Mountain Railroad Line.—The Chicago, Milwaukee and Puget Sound Railroad is to electrify 450 miles of its main line between Harlowtown, Montana, and Avery, Idaho. The Great Falls Power Company which will furnish the electric power has received a fifty-year grant from the Department of the Interior to transmit current over public domain under strict government regulations.

Transmitting Range of Arlington Station.—In order to determine the maximum range of transmission of the new wireless telegraph station at Arlington, Va., the cruiser "Salem" has been sent out upon a voyage over the Atlantic. The cruiser will endeavor to keep in touch with the Arlington station and determine the exact distance or distances at which signals sent out from Arlington cease to be perceived. It is believed that the Arlington station will be able to transmit over a radius of 4,000 miles.

Electric Service Table.—A table has recently been put on the market which is of the ordinary library type but is also provided with four or more outlets or plug sockets, inconspicuously placed on the side below the table top. This affords means for connecting up electrical apparatus such as fans, cooking utensils, reading lamps, etc. In an iron box secured to the under side of the top are a meter, main switch, fuses and the necessary wiring. Connection with the lighting main may be made through a steel conduit passing from the iron box through the baseboard to the outside wall of the building. This simple device comprises all the electrical outfit necessary for the electrical comforts of a living room. By using extension cords a vacuum cleaner may be efficiently employed all over the house.

Electricity in the Drafting Room.—Two applications of electric heating in connection with drafting work are referred to in an English electrical magazine. One is the use of a portable combination heater and fan, ordinarily employed by hairdressers to dry their customers' hair after washing, to dry the ink on tracings. This "wrinkle" shortens the time required to complete the tracing, as the freshly inked lines must be dry before T-square or triangle can be moved over the tracing; and in the damp climate of the British Isles the scheme might find considerable application. The other idea, which has been used in this country also, is to dry blueprints by going over them with an electric flat-iron; and the flat-iron is also useful to straighten out tracings and prints that have been rolled or folded.

Mercury-vapor Rectifier of Large Power.—In the ordinary mercury-vapor rectifier using a glass vapor chamber the amount of electrical energy that can be converted from alternating to direct current has been limited, and the use of this form of energy converter has been confined to such comparatively small power applications as the charging of automobile storage batteries from alternating current mains and similar light work. A recent German type of rectifier has been developed for converting larger amounts of energy, the inclosing vessel being a sheet-steel cylinder. The gas-tight joint is formed by a double packing of asbestos or similar material, with a layer of mercury in between. A 220-volt, 80-kilowatt rectifier of this type has been in use since November, 1911, supplying the power plant of an iron foundry for 10 hours daily, operating from single-phase 2,080-volt mains. A 100-kilowatt steel rectifier weighs only 1,060 pounds as compared with the 4,200 pounds weight of an ordinary rotary converter of the same capacity.

Exploring for Gas with Electric Arcs.—During the excavation of the tunnel through the Santa Ynez Range in California for the Santa Barbara aqueduct, so much gas was encountered that special means had to be devised for the protection of the workmen. It was decided to ignite the gas with electric arcs. For this reason arcs were placed in pockets in the roof of the tunnel, about 200 feet apart. Half an hour after a blast was fired, the arc circuits were closed, and by means of ammeters it was possible to determine whether they were burning. If no explosion of gas resulted from this, the fire boss entered the tunnel and proceeded a distance of 3,500 feet to the second arcing station. Here the current was again switched on, and if there was no explosion, he proceeded with his gang of men to explore the tunnel with a safety lamp in search for pockets. This done, torches were placed throughout the tunnel at distances of about 100 feet apart through the section in which the gas was encountered, and were kept burning while the next shift was at work on the heading. Four hours were thus consumed in precautionary measures, between shifts,

Science

Solar Radiation Concentrated by Clouds.—In the Bulletin of the Mount Weather Observatory Messrs. H. H. Kimball and E. R. Miller call attention to the paradoxical fact that clouds, when favorably situated, sometimes increase the intensity of radiation from sun and sky received by a body on the earth as much as 40 per cent over what would be received if the sky were perfectly clear; while increases of 10 per cent from this cause are quite common. This is shown by the records of the horizontally exposed Callendar pyrheliometer, which makes a continuous registration of the vertical component of the radiation from sun and sky, and the phenomenon is explained by the fact that radiation reflected from the cloud surface is added to that coming directly from the sun.

The International Map of the World, on a scale of 1 to 1,000,000, will, when completed eight or ten years hence, cover a total area of about 150 feet by 75 feet, or the surface of a globe 40 feet in diameter. It will consist of about 1,500 sheets, each representing a section of 4 degrees in latitude and 6 in longitude. The first sheet of the United States portion has just been published by the Geological Survey, in Washington. It is known in the general scheme as "sheet North K 19," but will be more popularly known as the "Boston sheet," and embraces Rhode Island, and portions of New York, Connecticut, Massachusetts, New Hampshire, Maine, and Nova Scotia. It is printed in six colors. Ocean depths and terrestrial altitude are shown by contour lines and graduated tints. It represents the beginning of a more accurate map of the United States than any that now exists.

Ozone for Preserving Meat.—An important improvement in the technique of cold storage has recently been introduced in Germany; viz., the use of ozone as a supplement to the ordinary process of refrigeration. In the cold storage rooms attached to slaughter-houses the temperature of the air is liable to be raised to a serious extent when the doors are left open for any reason; for instance, when meat is being put in or taken out. The microorganisms of putrefaction immediately become active under such circumstances and the keeping quality of the meat is diminished. Now it is well known that ozone is a powerful germicide. If the air of the cold storage room is ozonized, its temperature may be raised without injury to the contents. This has been proved by numerous experiments, and ozonizing apparatus has now been installed in the abattoirs at Cologne, Potsdam, Brandenburg, Berlin, Frankfort-on-the-Main, Düsseldorf, Freiburg (Silesia), Aix-la-Chapelle, and Erfurt; in a cold storage depot in Hamburg, and in various dairies, poultry and game stores, and fish establishments.

The Progress of Aerology.—*Petermanns Mitteilungen* publishes an abstract of the presidential address of Prof. Dr. Hergesell at the seventh meeting of the International Commission for Scientific Aeronautics, held in Vienna, May 27th to June 1st, 1912. (This commission, by the way, has a misleading name, as it is not concerned with the navigation of the air, scientific or otherwise, but with meteorological investigations carried on with the aid of kites and balloons.) The president reported that since the commission last met, in 1909, twenty aerological stations had been added to the international *rescau*, including some in countries where no upper-air research had previously been carried on; viz., the Dutch East Indies, Argentina, Uruguay, Iceland, and Canada. The commission has two observatories under its immediate direction; one on the peak of Teneriffe, and one in Spitzbergen. The former has made observations of the trade and antitrade winds up to an altitude of 11 miles by means of more than 800 ascents of pilot-balloons. The latter is making important researches on the atmospheric circulation around the North Pole, especially in co-operation with various Arctic expeditions.

Micrometer Positions of Halley's Comet.—In the *Astronomical Journal* (No. 19, Vol. XXVII) Prof. E. E. Barnard publishes some micrometer positions of Halley's comet made with the 40-inch telescope of the Yerkes Observatory. Prof. Barnard states that in the last few observations before its final disappearance it was excessively difficult to make the measures, partly because of the poor condition of the sky. Still Prof. Barnard is so accurate and skillful an observer that his data will undoubtedly be accepted by every astronomer. The small field of the 40-inch telescope made it difficult to secure proper comparison stars on observations. Hence it was necessary in many cases to connect the comet with a faint star near it and then to compare this with a known star. The positions of these intermediate stars are given in Prof. Barnard's paper. Prof. Barnard also publishes in the *Astronomical Journal* a few notes made at the time of observation, and promises to publish in a later paper the main mass of notes. "These last give a detailed description of the naked eye appearance of the comet, and I think," Prof. Barnard states, "will be of service to astronomers at future returns of this object. Such information seemed to be sadly lacking in 1910 in connection with the return of 1835."

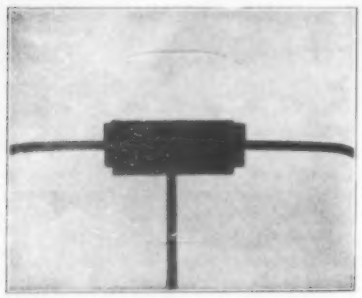


Fig. 1.—Side view, showing cylindrical shape of wave.

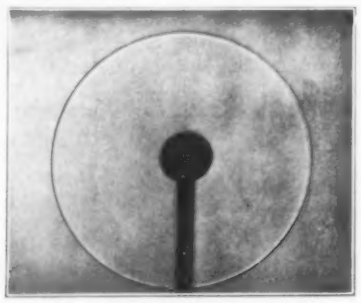


Fig. 2.—A simple sound wave seen end-on.

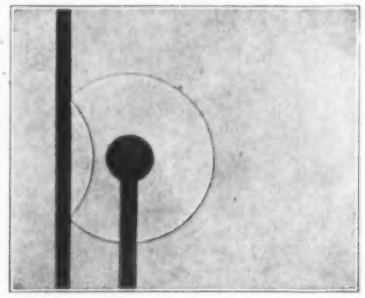


Fig. 3.—Sound wave reflected from plane surface.

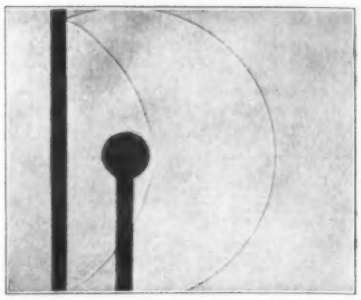


Fig. 4.—The same wave, photographed a moment later.

Seeing Sound

Snap Shots of Waves Traveling at Seven Hundred and Fifty Miles Per Hour

IN our day one does not need to be a physicist to know that wave motion of one kind or another plays an important part in nature and in technical applications of natural phenomena. The simplest and most obvious type of wave motion—the one to which the name is primarily applicable—is that which we observe in the ripple in a teacup, a surface-tension effect, or in the mighty ocean billow rolling on under the action of gravitation. Such waves are essentially two-dimensional—at least their direction of propagation lies in a plane. A typical wave front in this case, such as that produced by a stone falling into a pond, is circular in form.

Other waves, and a very important class, are three-dimensional, the typical form being spherical, each wave starting out from a point source, and spreading out as a sphere with that point as its center. Light waves are of this character, as well as the waves used in wireless telegraphy. In fact, as our readers know, the two are propagated with the same velocity through vacuum, and are identical in character except as regards their wave-length, which is of the order of one fifty-thousandth of an inch in the case of light, and of the order of several thousands of feet in the case of the electric waves commonly used in wireless telegraphy.

While the circular waves on a sheet of water are readily observable and known to every child, it is only by special means that spherical waves can be rendered visible. Light waves are themselves of course invisible—contradictory as this may seem. A beam of light passing through a perfectly dustless space is absolutely invisible to an eye looking across the beam. In this sense it may indeed be said that no eye has ever "seen" a wave of "light." But there is another kind of spherical waves—sound waves—which, though ordinarily quite as invisible as waves of light or electromagnetic waves, can nevertheless, by suitable means, be rendered observable to the sense of sight. A particularly fine method for effecting this has recently been developed by Prof. A. L. Foley of Indiana University, in collaboration with Mr. W. H. Souder. By the kind permission of Prof. Foley and the courtesy of the editor of the *Physical Review*, in which the first account of this method appeared, we are enabled to give here an indication of the nature of the process followed, and to show some of the very fine photographs obtained.

The method is best explained by reference to the diagram Fig. 5, which shows the apparatus employed.

Four spark gaps S, I, TK, and T_sK_s are arranged in series in a circuit in which a large electric induction machine is included.

The gaps TK, T_sK_s serve merely as a means for producing a spark at the desired moment by turning the glass plates GG out of the way—these plates being normally interposed between the knobs T, K, T_s, K_s.

Every time a spark is thus caused at TK, T_sK_s, a similar discharge occurs at the gaps S and I also. The "sound gap" S is so arranged as to give a loud discharge, thus sending out a sound wave consisting of alternate layers of compressed and rarified air. The gap I, on the other hand, has its terminals made of magnesium wire, so as to give a brilliantly luminous discharge. The Leyden jars K_1, together with other features that cannot be discussed in detail here, serve to delay the discharge at I so that it occurs by a minute fraction of a second later than that at S. Hence the light from I arrives at S when the sound wave has traveled a certain distance out from its source. A photographic plate (or the observer's eye) is placed at P, and as the layers of air of different density, of which the sound wave is formed, have different refracting powers, the appearance shown at P is that of a dark ring on a light background.

The waves produced by this apparatus are not strictly spherical in form, but consist of cylinders with hemispherical ends. As these are viewed end-on, however, the appearance presented is exactly the same as if we were dealing with spherical waves

Of the photographs so obtained, we reproduce a few typical examples. Fig. 1 is a broadside view, showing the cylindrical form of the wave. A simple transverse

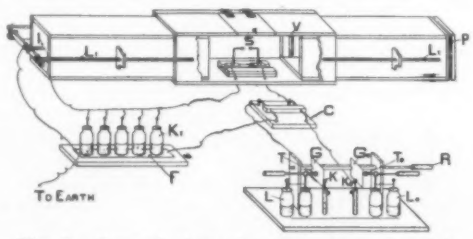


Fig. 5.—General view of apparatus employed in photographing sound waves.

section is shown in Fig. 2. Very interesting is Fig. 3, which shows the appearance presented when the wave hits a reflecting plane obstacle ("mirror"). The forward part of the wave (on the right) travels on unchanged, but a similar secondary (reflected) wave is produced at the reflecting surface, and travels out in pursuit of the original wave, as seen in Fig. 4, which represents the state of affairs at a slightly later instant.

The action of a lens (sulphur dioxide contained in a collodion envelope) is shown in Fig. 6. It will be seen that the wave, starting from the focus of the lens on the right, emerges as a plane wave (parallel rays) on the left. A similar effect produced by a parabolic mirror is shown in Fig. 7. Here also the wave emerges after reflection as a plane wave. A very interesting case is shown in Fig. 8. A wave starting out from one focus of an ellipse (at which the knob of the sound gap appears) is reflected and brought to a point at the other focus of the ellipse. Finally, a very fine interference pattern is produced, as shown in Fig. 9, by a cylindrical grating placed in the path of the sound wave, with the source at the center.

It may be remarked that more recently Prof. Foley has further extended his researches, using the method here outlined, for the study of the electric spark discharge.

Those of our readers who may be interested in the details of the experimental arrangement designed by Prof. Foley will find a full account of these in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT.

The New Campanile at Venice

THE new campanile of Venice shows some interesting points of construction. When it was decided to rebuild it, the principal question was to provide against a repetition of the catastrophe which befell the original tower. It is known that Venice, constructed as it is upon the lagoons, gives a very defective foundation soil, and this appears to be the reason why the old campanile fell down, owing to the overloading of the foundations. In fact, the tower had 280 feet height and over 13,000 tons weight, and gave a pressure of 13 tons per square foot upon its foundations. In erecting the new tower, the commission provided for better conditions by strengthening the foundations and at the same time lightening the weight of the construction by another method of building, also by consolidating the different parts of the tower so that there is no danger of dislocation. Reinforced concrete came in very well to carry out these ideas, and it enabled the engineers to give more space to the interior without changing the outside appearance in the least. The side walls are now very well joined together by means of the spiral staircase which passes up through the center of the tower so that the whole mass has a much greater solidity than before. The use of reinforced concrete allowed of reducing the thickness of the walls considerably, and the new construction now has three quarters the weight of the old one. For the foundation over 3,000 new piles were driven so as to make it much stronger than before. The piles uphold a foundation base in hard stone, and the load upon the ground is now reduced to 4.7 tons per square foot, which is well within safe limits. The spire, which terminates the tower and is 96 feet in height, is well braced inside by reinforced concrete members and rests upon a platform foundation of the same material. Only the framing for the support of the bells is of metallic construction. The elasticity of this part, as well as the greater flexibility of the whole edifice, is counted upon to reduce the oscillations of the tower upon the foundations due to the effect of the wind, and also the vibrations caused by the bells. It is thought that these effects played a large part in the destruction of the former tower, and that they will now be overcome to a great degree. On the whole, the builders used great pains not only to keep the outside appearance of the tower as nearly like the old one as possible, but to redesign the body of the construction on the most modern principles in order to obtain the greatest possible strength, and thus diminish the likelihood of any similar accidents in the future.

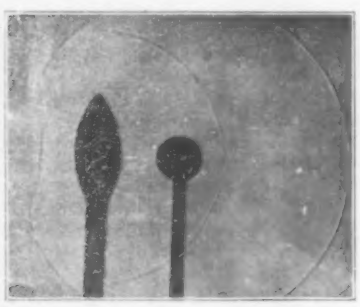


Fig. 6.—A lens converts a spherical into a plane wave.

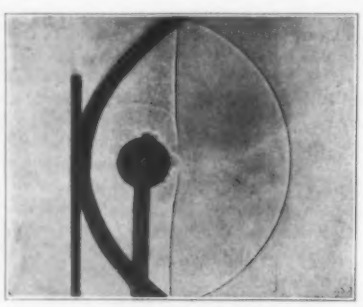


Fig. 7.—Similar effect produced by a parabolic mirror.

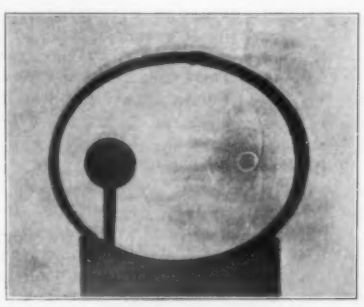


Fig. 8.—Reflection from one focus of ellipse to the other.

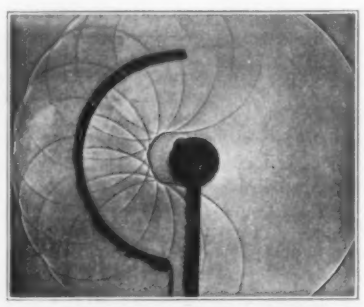


Fig. 9.—Diffraction pattern produced by a grating.

Co-operation in Educational Effort

THE recently issued annual report of President MacLaurin of the Massachusetts Institute of Technology discusses the need of co-operation in educational effort. To the students and alumni of the Massachusetts Institute of Technology the question is one of great importance in view of the proposed merger of the Institute with Harvard University. Admitting that there has been much friendly co-operation between Harvard and Technology, and prophesying an even closer relation in the future, now that the Institute is about to move to Cambridge, President MacLaurin nevertheless maintains that, with regard to any scheme that might be proposed to meet the actual conditions at Harvard and Technology, it is impossible to maintain extended co-operation with any satisfaction to either institution, and consequently with any chance of permanence, unless the idea of competition is eliminated. Furthermore, he maintains that extensive co-operation to be worth much consideration must be broad enough to throw open the resources of both institutions (in equipment as well as in men) to at least some of the students of the other. He also insists that the obvious way to co-operate is in the treatment of the graduate students, leaving the greater part of the Massachusetts Institute of Technology entirely alone.

The necessity for co-operation in educational effort is nowhere more apparent than in the relations of technical institutions to our universities. Education suffers in few ways so much as through lack of co-operation among those colleges, universities, and schools of applied science which not only should be laboring together for the common good, not only should be avoiding by agreement those duplications of resources and of effort that keep them all painfully poor, but also should be devising some plan by which students may be transferred from one to another without loss of time and effort.

A few examples may give definiteness to these general statements. If Harvard were to duplicate the complete mining and metallurgical laboratory which the Institute of Technology is planning to build and equip, the community would be called upon to expend hundreds of thousands of dollars for mere duplication, and yet all the students of mining and metallurgy at Harvard could easily be accommodated in the Institute's new laboratory without detriment to the Technology students. Similarly, it would be folly for the Massachusetts Institute of Technology to spend hundreds of thousands of dollars to duplicate the University's museum, whose great collection of minerals and fossils might be opened to the senior students at Technology without inconveniencing the regular students of Harvard. The building of an experimental tank in the Institute of Technology, a step considered by competent authorities to be a necessary part of a department that is fully equipped to advance the science of shipbuilding, would suffice very easily for two or more neighboring institutions.

Such duplication, however, does not represent the entire waste of the present system. "More serious than any duplication of machines," says President MacLaurin, "is the loss that falls upon the community by excluding advanced students of each institution from the benefit of coming under the influence of the pioneers of science in the other institution, men whose character and attainments make any suggestion of 'duplication' absurd. For years the advanced students of geology at this Institute have been stimulated by Prof. Daly's skill and enthusiasm as a teacher as well as by his scientific achievements. Now that he has gone to Harvard, it is regretable that such students should be cut off from his influence, especially in view of the fact that the advanced students of Harvard and Technology together would not be too many for a man of his capacity to deal with effectively. Indeed, in such cases there is a loss rather than a gain in efficiency, merely from the educational standpoint, where the number of students is unduly small."

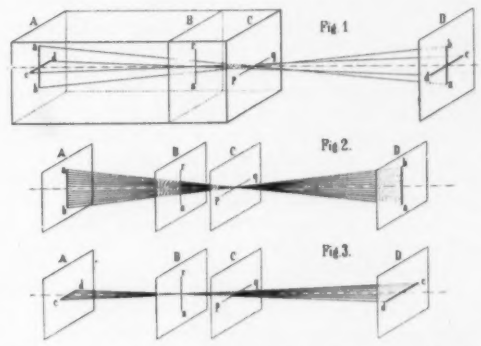
President MacLaurin's discussion of efficiency in education was rendered necessary by the decision that there can be no merger with Harvard. The Institute seems strong enough to stand alone or to enter, if it wishes, into relations of co-operation in educational effort. Because the latter term might be misunderstood, and serve for a cause of dissension, President MacLaurin laid down the broad fundamental principles of co-operation with Harvard.

Anomalies in Automobile Terminology.—Automobile terminology, to many of those who call themselves engineers, must be a despair if their efforts at elucidation and the naming of parts can be taken as a guide. Despite the evident redundancy, apparent in the derivation of the word "pedal," "foot pedal" is one of the most common of errors that appears in nearly every piece of automobile advertising, while one "engineer" who would be more than ordinarily explicit has advertised that the brake is operated by the "right-hand foot pedal."

The Slit Camera

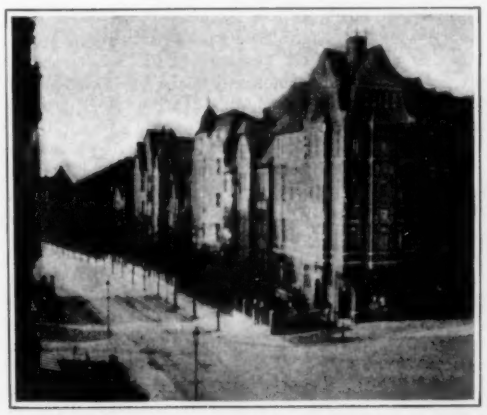
By Our Berlin Correspondent

THE slit camera, designed by Mr. Wolfgang Otto, of Kiel, Germany, is an ingenious device on the pinhole camera type, and is intended for producing any distortion desired. It comprises on the side turned toward the object, two crossed slits arranged in partitions situated behind one another. The slits may be straight or curved, of any width desired, and the distance of the partition from the plane of the image may be varied at will. The partitions may also be curved or slanting if desired. The camera can, of course, be designed at will as folding camera, bellows camera, etc.

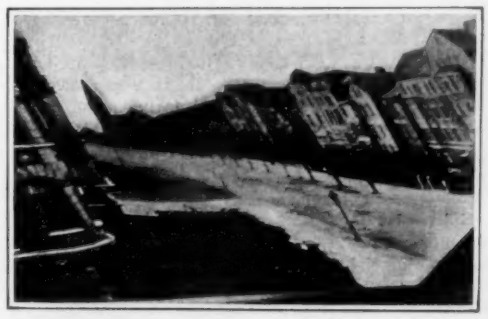


The Otto slit camera for producing distorted photographs.

Block of houses fore-shortened vertically by the slit camera.



The same block with vertical lines exaggerated in length.



Deformation produced by the use of slanting slits.

In order to make the fundamental principle clear, we shall consider the case of a camera comprising straight slits of uniform width, the plane of the image *A* and the partitions *B* and *C* being vertical, while one of the slits (*p q*) is horizontal and the other (*r s*) vertical. The picture of the object *a b c d*, which is then produced on the screen *D* shows a deformation, the scales in a horizontal and vertical direction, respectively, bearing to one another the same ratio as the distances of the two slits from the focal plane.

If we follow a moving point along the line *a b* of the object at *D* (Fig. 2), the beam of light passing from such point to the image screen at *A* will, as it were, pivot about the slit *p q* in the partition *C*. Similarly if the point of the object considered moves horizontally along *c d*, the corresponding beam of light will pivot about the slit *r s* in the partition *B*, and the same applies to the horizontal beam of rays represented in Fig. 3.

Thus vertical lines of the object are thus gathered into an image at *A* by the slit *r s*, while horizontal lines are similarly gathered into an image by the slit *p g*. Owing to the difference in the distance of the two slits from object and image, they form two images of different magnitude. But this amounts to saying that the resultant image represents vertical and horizontal features of the object on two different scales—or in other words, the resultant image is distorted.

Other deformations may be produced by providing slanting partitions, slits of varying width, or curved. In many cases the conditions determining a given deformation can be found by calculation. Moreover, instead of a single slit, any number of slits can be provided in the same plane.

The slit camera is not a mere scientific toy, but can serve many useful purposes. Thus it may be used for rapidly altering architect's plans, or for producing comical caricature effects by deformation, for varying any given pattern for fabrics or carpets, and for altering the different forms of type.

The slit camera can be readily made by everybody and will be found an inexhaustible source of amusing experiment.

Popular Ignorance About Our Common Woods

MODERN culture in no small measure despises natural history. Wood experts observe constantly from their intercourse with their fellows, that even among the well educated people there prevails a general lack of acquaintance with the commercial woods. Among the wood users of the present day what knowledge they have upon the woods is generally that of a few superficial and unrelated facts, mixed, perhaps, with a number of incorrect ideas concerning their physical properties and their suitability for certain uses. It is also a rather remarkable fact how prone people are to confound the names of well known species of woods, which, though closely related, possess, notwithstanding, clearly marked distinctive characters. Thus, experienced lumbermen or timber merchants call spruces "firs," pines "spruces," maples "sycamores," and even trained foresters sometimes class the cigar box cedar (*Cedrela odorata*) with our common red cedar or juniper. This confusion of knowledge exists also with relation to species which have been made familiar to a number of laymen in the local lumber yards where, for instance, western yellow pine is sold as white pine, and red oak as white oak.

There is no material in such common use as wood, and it may be from this very circumstance of its being so plentiful that it is looked upon by people as beneath their notice. The average man in the street is unable to tell the distinctive features of the wood of ash and that of chestnut, and he does not regard such facts entitled to any consideration. The same person would feel offended if he were told that he did not know the difference between a mushroom and a toadstool; as a matter of fact there is no botanical or other distinction whatever. A knowledge of the chief external appearance of wood and their more prominent structural characteristics will be found upon investigation to be highly interesting and often prove to be of considerable value. It is a knowledge and understanding of the characteristics of our common woods, by which the relation of structure and external features is clearly indicated and defined, that the people generally are most lacking. Not many possess the ability to group woods having like structural characters.

The study of woods has indeed latterly received more attention than formerly as a branch of education, and made a part of the courses given in forestry and other technical institutions. It should be made a part of the common school exercises. But the teachers have themselves no very clear understanding of the characters of the chief commercial woods, and a short course of instruction must first be introduced into our training schools for teachers. Instructions of this character can fitly be introduced in connection with sloyd work.

There is hope that the coming generation will be better posted upon the principal characteristics of woods. In this respect the people of Germany have progressed considerably more than the English or the Americans. The Latin names employed for a good many structures in wood have been perhaps the chief difficulty, and discouraged many persons from acquiring a better knowledge of woods. This difficulty is now fast disappearing, for easier terms are being applied to such structures which are most essential to a knowledge of woods.

Building a Four-track Tunnel Beneath Broadway, New York

DWELLERS in Manhattan, and outside of it for that matter, will long remember the intolerable discomfort which attended the construction of the present subway. Unsightly cableways stretched above chasms which yawned where once the street had been; sidewalks were littered with timber, tools and the various impedimenta of the contractor; carts backed up to receive the excavated material, selecting loading positions which, though they may have suited the convenience of the contractor, certainly had no reference to the comfort of the street and sidewalk traffic. Dust in summer—dirt in winter—obstructions everywhere, the four or five years spent in building the first subway developed a prejudice against the new transit system, which it took all of the road's admitted excellence for the first year or two of its operation to dissipate.

We learned well the lesson taught in 1903, and adjacent years. In 1913 we are again building subways; but we are doing it with many notable differences, the chief of which is that the many nuisances which accompanied the earlier work have been entirely abolished from the new work. Formerly, a whole section of the street, or, if that particular neighborhood were fortunate, one half of the street, was closed and a huge open excavation was maintained until the work had been carried down to the full depth. That was what the engineer calls excavation by "open cut." Today our subways are built by what is known as the "cut-and-cover" method, which is being so carefully and conscientiously followed, that a large proportion of the millions of people that pass up and down Broadway on foot, in motor, or on street-car, are in complete ignorance of the fact that a four-track express railroad is being built in a tunnel immediately below.

On the front page of the present issue is a drawing which explains how this work is being done. The view is taken on Broadway at the point where the new City Hall Station of the new Broadway line is being constructed. South of the City Hall, the route lies under the streets to the west of Broadway, until it reaches the Battery, when it passes below the East River to a junction with the Brooklyn Rapid Transit System. North of City Hall Park the subway extends up Broadway to the neighborhood of Times Square, and thence up Seventh Avenue to Fifty-ninth Street, where it will turn to the east through Fifty-ninth Street and cross the Queensboro Bridge to Long Island City.

The section of the work herewith illustrated, which is being built by the Degnon Contracting Company, to whom we are indebted for courtesies in our examination of the work, extends from Walker Street to Park Place, a distance of about 2,800 feet. The tunnel contains four tracks as it approaches the station, which contains five tracks. Two of these are carried on an upper deck, the other three below, the total depth of the excavation here being about 41 feet, and the total width something over 75 feet. The material is favorable for excavation, being entirely sand, of which there are in this section about 230,000 cubic yards.

A most important work, preliminary to the excavation, was to remove two gas mains, 12 inches and 16 inches, respectively, in diameter, temporarily from the excavation, and carry them above ground—this to guard against possible explosions due to leakage. The mains were diverted at each end of the work, and carried above the sidewalk upon temporary trestles, as shown in the front-page engraving.

The first operation in excavating by the "cut-and-cover" method is to sink a series of shafts, placed generally on the side streets, just off Broadway. These shafts on the City Hall section were sunk at the Park and at Worth and White streets, and they were carried down to the depth of the first bench of the excavation, or, say, about 16 feet. The next step was to remove the street paving for its entire width and for a length along the street of forty or fifty feet, and lay down a series of parallel, longitudinal 10-inch by 10-inch timbers, spaced five feet apart. On these was laid a roadway of 5-inch plank. The space between the two tracks was covered by two layers of planking, one of 3-inch and one of 4-inch, the first transverse, and the second, or upper layer, longitudinal. When this was done a smooth roadway of timber was thus provided in place of the asphalt or Belgian blocks.

The excavating gang then entered the side shafts, and with pick and shovel began to excavate across the street. As the work advanced, they placed 12 by 12 posts beneath the 10 by 10 timbers which carried the roadway planking, the excavation being carried on until it was completed to the opposite side of the street. Temporary footings for these posts were placed on the bottom of the excavation; the transverse lines or bents of supporting timbers were placed ten feet apart, measured in the direction of the street.

The excavation and timbering, as thus described, was carried down to about the 16-foot level below street grade. Above this level, it will be remembered, the supporting posts were placed at 10-foot intervals; below, the character of the construction made it necessary to place the posts at 20-foot intervals. Moreover, it was desirable to put these posts, which were 25 feet long and reached to the final bottom of the excavation, in place, before the dirt was taken out. To do this, timbered shafts measuring 3 feet by 4 feet were sunk down to subgrade, and into these the 25-foot 12 by 12 posts were lowered, a concrete slab having been prepared at the foot of each shaft, as a footing or foundation. At the top of the 25-foot posts were the caps and longitudinal stringers, upon which the upper and shorter lengths of posts rested, and which served to tie the transverse bents together. The whole system of falsework was thoroughly braced, as shown.

The excavation was done by pick and shovel, the dirt being loaded into buckets, on small contractors' cars, which were pulled back from the headings to the hoisting shafts either by mules or electric locomotives, where they were hauled up by electrically-operated derricks and dumped into hoppers. The latter were built on platforms spanning the street or the sidewalk, which were capable of holding thirty yards apiece. From the hoppers the material was dropped directly into the the contractor's carts, which carried it to the dump or wherever it was being disposed. The disposal of the excavated material is one of the serious problems of city subway construction.

Some very successful excavating was done by means of a belt conveyor and elevator. The conveyer extended across the cut opposite the hoisting plant, which was located in the shaft near the corner of Chambers and Broadway. The material was hauled in cars by electric locomotives, dumped into a hopper, loaded onto the belt conveyor, and carried to the boot of the elevator, whence it was taken up and deposited in hoppers upon the platform.

During the progress of excavation, the sidewalls of the tunnel are protected against caving in by means of three lines of vertical sheet piling driven as shown in our front page illustration. The piling is braced by a series of 10 by 10 struts, which are carried back and bed against the longitudinal timbers of the 25-foot carrying posts already referred to.

When the excavation had been carried down to subgrade, the heavy floor of concrete, about 2 feet 6 inches in thickness was laid, and the work is to-day so far advanced that the concrete floor is completed for a length of 500 feet.

The next step will be the erection of the steel columns, the construction of the steel work of the floor and roof and sidewalls, and the turning in of the concrete arches which, with the embedded steel, will form the sidewalls and roof of the finished structure.

An important and costly section of this subway building is the provision which must be made for supporting the front walls of the buildings which line the route of the tunnel. In the case of the more recent buildings, whose foundations have been carried down to rock, no change is necessary; but in the case of older buildings, such as the Stewart building, shown on the right in our illustration, whose foundations were far above the bottom of the tunnel excavation, it was necessary to resort to "underpinning."

Steel needle beams were run at intervals through the foundation walls, their ends resting upon timber posts of sufficient strength to carry the entire load of the front wall. Masonry was then built in below the wall, until the latter continued without a break down to a point slightly below the floor of the subway.

It will interest the readers of the SCIENTIFIC AMERICAN to learn that the first tunnel below Broadway, constructed over forty years ago, on the plans of the late Alfred Ely Beach of the SCIENTIFIC AMERICAN, was located at the point where the section shown on our frontispiece was taken.

Our thanks are due to Mr. Burdette Kipp, assistant engineer, and Mr. R. P. Gustin, engineer in charge, for their courteous assistance in furnishing opportunities for the preparation of this article.

A Feathering Air Propeller

IN the mechanical engineering laboratory of Columbia University a test was recently made of a feathering air propeller invented by Ciro F. Mendez. The propeller was eight feet in diameter and weighed 193 pounds. Of this weight 76 pounds was the weight of the blades and 117 pounds the weight of the hub and the mechanism for feathering the blades, a weight not excessive for a dirigible airship propeller.

In carrying out the test the propeller was mounted on a frame free to move in a horizontal direction by the action of the propeller upon the air. The amount of thrust was measured in pounds by a spring balance. Power was applied from an electric motor through belting in such a manner as not to affect the movement of the table; in other words, power was applied directly over the center of rotation; the weight of the frame of the propeller was carried upon anti-friction rollers, and the friction error was eliminated by measuring the pull, including the friction and minus the friction, adding these together and dividing the result by two. A series of runs 155, 200, 250 and 300 revolutions per minute were made and the amount of current and thrust recorded. After the capacity of the apparatus had been learned, a brake pulley was attached to the propeller shaft and arrangement made for reading directly the amount of power transmitted to the propeller. In this series of tests, the propeller was driven at each of the speeds referred to and the readings of the voltmeter and ammeter recorded; also, the thrust of the propeller. Then the coupling in the propeller shaft was disconnected, the brake band and the brake attached, and the test run at the same reading of the voltmeter and ammeter, thus determining the actual power delivered to the propeller and eliminating the electrical and mechanical efficiency of the motor, belting and shafting.

The amount of work done by a propeller is its resistance against revolution, measured by its thrust, multiplied by the distance of travel of the center effort of the blades. The radius of this center of effort was 3.06 feet from the center, the resistance of a radial surface of rotation varying as the square of resistance from the center of revolution. The product of these two forces divided by 33,000 expresses the work done by the propeller in horse-power, and the reading of the brake determines the actual power applied to the propeller. The efficiency of the propeller was then determined by dividing the work appearing from the action of the propeller by the total power applied to it. From this it appeared that the efficiency at 155 revolutions was 70 per cent, at 200 revolutions 70.5 per cent, at 250 revolutions 75.2 per cent, and at 300 revolutions 88 per cent. This may be considered an exceedingly satisfactory result. A thrust of 39.12 pounds was developed for an expenditure of 7.73 horse-power, which force is available at any time in any direction; for by revolving a cam, which controls the feathering of the blades, it is possible to apply the thrust to drive the airship ahead or backward, to cause it to rise or descend without interfering with the speed or action of the engine.

Molecular Structure and the Origin of the Elements

CONCEIVED in the mind of ancient Greek philosophers, the atomic theory of the "grained" structure of matter was revived in 1803 by John Dalton, to account for the fundamental law of chemistry, according to which every compound contains a definite and invariable proportion of its constituent elements. But the atomic structure of matter interests the physicist quite as much as the chemist, for is it not, according to the kinetic theory, the impact of gas molecules against the walls of the containing vessel which causes the gas to exert a pressure on these walls?

And we have long ago grown accustomed to look upon heat as "a mode of motion"—the dance of the molecules. But while these qualitative conceptions of the grained structure of matter are comparatively easy to comprehend, it has taxed the ingenuity of men of the highest scientific genius to develop the mathematical theory and to enable us to calculate the size of hydrogen molecules, of which forty-two million millions could be packed into the volume of a single blood corpuscle! And it is the triumph of experimental skill not only to have rendered visible to the eye that very dance of the molecules, but to have actually counted them one by one, taking advantage of the flash of light which an α particle, a helium atom, gives out when it is shot out from a radio-active substance against a sensitive screen. And here the phenomenon of the grained structure of matter brings us face to face with another great problem: If there are different kinds of atoms, how came they by their several characteristic properties, the oxygen atom, for example, being invariably sixteen times as heavy as the hydrogen atom? Radium seems to hold a clue to this problem. It appears that some, at least, of the elements of higher atomic weight are continually undergoing disintegration, each atom of such element splitting up into others of lesser weight. And one product of the disintegration of radium is helium, as has been shown beyond doubt by Ramsay, Rutherford and others.

Have we then achieved the transmutation of the elements? Yes and no—yes, for radium is transmuted into helium and other products; no, for we have no control whatever over this excessively slow transformation.

This was but yesterday. To-day, if first accounts received prove authentic, we may answer our question with an unqualified "yes." For we read in the daily papers that Sir William Ramsay and Professors Norman Collie and H. Patterson have found newly formed helium and neon in bulbs originally containing hydrogen at a low pressure, and submitted to the influence of an electric discharge. This, then, so far as one is able to gather at the present moment, seems to be a definite case of transmutation (if not of creation) of elements under controlled and reproducible conditions.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

Panama Canal Problem in 1638

To the Editor of the SCIENTIFIC AMERICAN:

When was a Panama canal first thought of and discussed? It must be a very long time ago, because I have just been looking through a very old and very interesting book of mine on commerce, published in 1638. It gives a map of each continent as then known, and mentions with particulars of each all the towns available for commerce in each. The map and descriptions of the towns in America are naturally rather primitive, but the following paragraph occurs with reference to Central America and is, I think, of special interest at the present time: "Peruana contains the southern part of America, and is tied to Mexicana by the Straight of Darien, being 10 miles broad; some hold the Spainards did once intend to cut this straight through and make it navigable, and thereby shorten the way to the South Sea, China, Molluccos, but hitherto we have not heard that the same is any way attempted."

I thought your readers might be interested in this extract. H. ALLAN MORGAN.

Holmwood, Knutsford, Cheshire.

Electricity as a Factor in Plant Growth

To the Editor of the SCIENTIFIC AMERICAN:

From time to time reports have gone out as to the effects of electricity on the growth of plants. Nearly all of these effects are alleged to have been observed in close proximity to lines carrying heavy currents, but as yet little has been done in the line of observing the effects of this all-pervading but mysterious force. It is possible and probable that electricity will yet be found to play an important part in the growth of vegetation; and who can tell but what, when it is once understood, we shall see it working as great wonders along this line as it has along others.

As an instance of the room there is for the study of electricity as it affects plant growth, I shall relate an experiment I performed the past summer.

I had noticed that nearly all weeds are well provided with points. I also noticed that such plants as sugar beets, cabbages, etc., that are not provided with points, are affected by the close proximity of weeds to an extent out of all proportion to the amount of fertility the weeds would rob them of, and they are much more seriously affected by the weeds than are other plants that are provided with points.

Now it is a well-known fact that the atmosphere is charged with electricity, and that electricity is most readily taken up by points. I went ahead on the supposition that plants take from the air the electricity it is charged with, and that in some way this electricity is necessary for their best growth. I supposed that the unusually bad effect of weeds on smooth-leaved plants might be due in a measure to the electricity the weeds robbed the other plants of. In order to test my theory, I selected a sugar beet and a cabbage and kept them well cultivated, but set up among the foliage a number of wires with sharpened points and left them there during the season. The result was that these plants showed a much smaller growth than others not so treated.

So far the experiment seems to have borne out my supposition that electricity does materially affect the growth of plants, and that the points on plants are important agents in gathering this force. If on further investigation this supposed law holds good, it would play an important part in the selection of varieties best suited to avail themselves of the electric energy. There are many things about plant growth and soils that are but meagerly understood, and this field would seem to be one of the most interesting and profitable for scientific study.

Almena, Wis. R. E. DIMICK.

Ideal Automatic Train Control

To the Editor of the SCIENTIFIC AMERICAN:

Much valuable space has been given of late in your publications as well as others to the problem of automatic train control. For more than twenty years inventors have been working on this problem, and all along the same lines, that is to say, they try to provide means whereby a locomotive will be arrested automatically should it pass a signal set at danger.

The inventors have been working along this line because the heads of railways concluded that these disastrous accidents are due to the locomotive passing a signal set at danger. As in every other problem, the cause must be first found before the remedy can be applied. The inventors took the fact that "the locomotive passes a signal set at danger" as the cause. This is true; but why not investigate, and find the cause for the disobedience of a signal set at danger?

One of the railroads, about which there has been much discussion of late, gave out "specifications" setting forth the different characteristics which they expect an automatic train control to possess before they will consider the adoption of the same. Let me point out in this connection that even if this railroad company should find a system that will do all those feats set forth in its "specifications," this railroad company will be greatly disappointed if some time after the installation of such a system they should read in the "extras": "Big railroad wreck. Forty killed." Let me point out now that a system that will arrest a locomotive only on passing a signal set at danger, might at times protect the trains and at other times it will not, and the chances are just as much one way as they are the other.

Assuming a "block" to be a mile long and a train stalled at the end of this block, and assuming further that the mechanism operating the roadside device is in good condition, then any locomotive passing this roadside device, which was set to danger by the stalled train, will be arrested and brought to stop in time enough to protect both trains. The same thing will happen if there should be a broken rail near the end of the block. But all this assumes "ideal" conditions, i. e., all obstacles at or near the end of the block, and the fact that these obstacles can just as well be at the beginning of the block is ignored. No system, such as outlined above, could ever protect a train if the train be stalled 200 or 300 feet from the beginning of the block; nor could it protect the oncoming train if there be a broken rail within 200 or even 500 feet from the beginning of the block.

I do not think that a roadside device could be designed which would have a greater operating efficiency than the present-day automatic signals. Yet, perfect as these signals are, they do fail at times; and as perfect as such a roadside device may be, it will fail at times for the same reasons that the signals fail. The roadside device might be operated independently of the signal, yet it is possible for the track relay in both of the circuits to stick. Track relays often remain energized by stray currents, which act the same as though the block occupied by a train were clear, and the track relay for the roadside device would not be exempt from such a condition. There are many other conditions that have not been considered in the search for an "ideal automatic train control," and in which cases a train control, such as outlined above, would prove useless.

Thus it will be seen that the steps taken so far to solve this important problem are not altogether the right ones, and the solution lies elsewhere, but it does exist, and I know it will come. MAXIMILIAN WEIS.

The Real Problem of the Mississippi

To the Editor of the SCIENTIFIC AMERICAN:

The question of protection of the Mississippi River bottoms from overflow and the matter of canalization of the river from various points has been discussed in documents, which some of the debaters on these questions may not have read. The idea of building reservoirs on the headwaters of the Mississippi, for example, was put into one of the first of the many studies of the hydraulics of the great river by Mr. Charles Ellet, who afterward won renown as a fighting man during the civil war.

The classic report of Capt. A. A. Humphreys and Lieut. H. L. Abbot submitted to the Bureau of Topographical Engineers of the War Department in 1861 is, of course, the original source of much information on the Mississippi. The abbreviated "Levee System," is, perhaps, the more familiar edition of this report. The report very clearly and apparently irrefutably exploded many of the theories which to this day crop up in any argument—the reservoir notion, for example. The army officers, after the manner of their kind, collated everything that had been discovered about the Mississippi and its tributaries. They even gave the then meager rainfall records from the far and scattered forts on the westward slope of the river basin, for instance—those forts where army men, in the lonely routine of their daily lives, turned from the parade grounds to study birds and mammals and the lay of the land, enriching the literature of natural history—for instance, Capt. Bendire and Dr. Elliot Coues.

James B. Eads was the one, who after the civil war led in the combat against the Mississippi. His distinguished service led the SCIENTIFIC AMERICAN to propose that he be made president, and if he had been made president, the Mississippi River problem would not now be the brain teaser of all the solvers of the "How Old is Ann?" question.

The trouble with the Mississippi is that it fills up its channel with sediment, and the Government keeps right on building up the levees, till they are as high as the platform of the gallows of Haman, upon which they cut from under, and leave some people literally hanging to the grapevines. Mr. Eads said in effect that the levees should be built out from the highlands on the east and west side of the river valley perpendicular to the river channel. Then the overflow would be "eddied" and the sediment deposited among the trees. I have seen in a caving bank, and in a hollow tree places where sediment deposits were twenty feet deep—this in eddies of old. The purpose of the eddies, in pools made by earth dams across the bottom, perpendicular to the flow of the river, would be twofold; first, to build up the bottoms lands; second, to make the current swift enough to scour out its own bed, and carry the sediment till it swung out into the eddies out of the channel or on to the Gulf. Incidentally, the dams would serve as refuges.

That is to say, the greatest and till then the only thoroughly equipped student of the Mississippi solved the problem upward of forty years ago; but so perverse are the gentlemen who take levee contracts, and so conservative are the gentlemen who have the power, that the obvious remedy and, so far as any one has ever discovered, the only remedy has never been applied, except when the river itself roars through that tremendous folly—the levee system as built in recent years. I have not the figures here, but I question whether the floods last year were as great in volume as the previous floods—those of 1844, or of the early 80's.

I would suggest as food for reflection the fact that the streets of New Madrid were overflowed last spring for the first time; measurements of the river surveyors show that in four or five years the river channel in front of New Madrid filled in more than five feet. Below New Orleans it filled in nine or ten feet. No wonder that levees, with only a margin of a few inches, or eighteen inches, fail to hold when the place where the current is swiftest is deprived of a depth of five feet of freeway.

Those who desire to verify these statements may do so by referring to the Report on Survey of Mississippi River, Document No. 50, of the House of Representatives, Sixty-first Congress, first session, and to the reports of the Mississippi River Commission, especially for the year that describes the flood of 1903.

In addition to this study of the documents of the Mississippi River, the gentlemen desiring to know what is the matter with the river and with the controllers of the river should by all means go down the Mississippi and take jobs on the mattress work; perhaps pull an oar for the river surveyors—I think they use motorboats now, but when I was down there, they rowed—and listen to the things the men on the jobs say. A few hours in a levee camp, sitting around the commissary stove along toward the end of a levee contract, will add interesting supplementary evidence to that found in the documents. Sometimes it gets into the documents, for none writhes more, under the political phase of this matter, than the honest officers. It was on the Mississippi job, for example, that the army men waited for the hour when the nation would call them to the honest effort at Panama. Consider their feelings when they sent dredges to Wolf River, at Memphis, year after year, to take out sawdust.

The men who conquered Panama could conquer the Mississippi River; let no one doubt that. But just as long as the men on the Mississippi River job are held to the whims of congressmen and senators and levee boards, and even to the demands of cotton planters who own three miles fronting on a Government levee—just so long the Mississippi River shall go on its course, filling up its bed with 200,000,000 cubic yards of material, while the Government keeps on piling up its little levee system on both banks, doing very little permanent or adequate work.

On page 46, "Survey of the Mississippi River" (1909), is a little table. It tells how much the annual cave is in various river bends. The average from Cairo to Donaldsonville is 9½ acres to a depth of 66 feet, or 1,003,579 cubic yards. The distance by river is 885 miles. That is, 850,000,000 cubic yards of material washed down stream. During nine months of the year, floating sediment to the quantity of 187,000,000 cubic yards came down the Missouri into this lower river. Besides this floating sediment, the river of mud, sand and gravel at the bottom of the water must be reckoned with. In all, the Missouri is dumping fully 400,000,000 cubic yards into the Mississippi, where the Government is heaping up three of four million cubic yards of dirt a year, to counteract the effect of this channel deposit.

Why not bring the men who dug the Panama Canal back to the Mississippi and give them the opportunity to assail their ancient enemy, unimpeded by the contemptible politics that has restrained the impatient men who know what to do, and would do it to the everlasting advantage of the country? When those men were beyond the reach of the picayune influences, and were left at least sufficiently alone in their work they conjugated the verb To Do.

They are the men who know; they don't own cotton plantations, nor boom swamp lands, nor sit on railroad directorates, nor speculate in sugar and rice—they see their duty; and the one thing in all the world that they would rather do is their duty. All that stops them is the—we all know, and the more shame to us since we do know.

Give them a chance!

Little Falls, N. Y. RAYMOND S. SPEARS.

Fig. 1.—Armature for the "Whaleman" by B. L. Pratt.

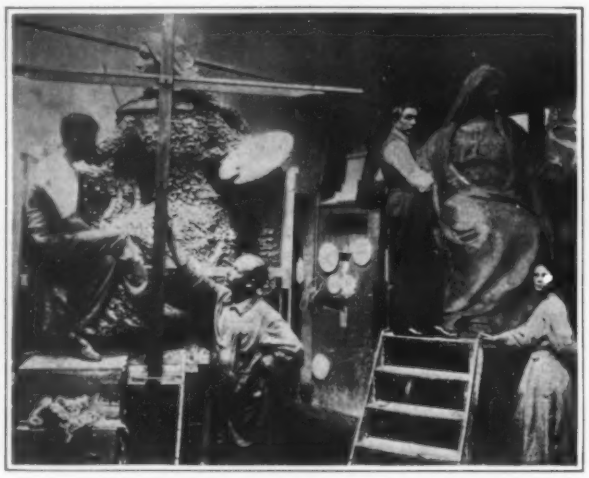


Fig. 2.—Pointing machine used to transfer from the model the location of nose, chin, etc.

Fig. 3.—The flask consists of iron sections clamped together.

The Art of Making Bronze Statues

From the Raw Clay to the Finished Figure

By C. E. Fairbanks

THE artist who portrays his conception in bronze encounters many obstacles which his brother of the palette and canvas never has to contend with. Among other difficulties is the fact that the work of the former has to pass through several hands other than his own before completion, whereas the work of the latter is begun and finished by his hand alone.

In giving expression to his conception the sculptor frequently "works it up" from a minute model in the rough, which but faintly suggests the portrait that is to be, to sizes larger and more detailed until finally the model for exhibition is finished. This model while expressing all the details may be much smaller than the desired size of the final work—especially if this is to be life size or heroic. For working material the sculptor uses either wax, modeling clay, or some special composition, which, in addition to being plastic, will retain its shape indefinitely and support a very considerable weight. To avoid excessive use of clay, but principally to stiffen the figure, a skeleton framework is constructed and is known as the "armature." Fig. 1 shows the "armature" for the whaleman—with poised harpoon—in the New Bedford (Mass.) Whaleman Memorial by B. L. Pratt. A "pointing machine" consisting of a vertical stand with a multiplying horizontal arm is used to transfer from the accepted model and locate on the armature such points as nose, chin, knees, etc., as this framework is assembled. The clay is then plastered on roughly and afterward shaped to a finish, as is shown in the view (Fig. 2) of B. L. Pratt's studio; at the left being the figure of "Art" for the Boston Library with the clay roughly plastered on the armature, in front of it being the "pointing machine;" at the right Mr. Pratt is finishing off the figure of "Science," while in front stands the woman model.

After all finishing touches have been put on, the sculptor turns the clay portrait over to the plaster-cast men, who mold about it a shell of plaster of Paris. This shell is then removed by inserting sharp metal pieces about 4 inches square along certain lines, depending upon the contour of the figure, and by this means splitting the shell into sections, which enables it to be removed entirely. The shell is then reassembled, and as this progresses a rough framework not unlike the original "armature" is built up inside of the reassembled shell—excelsior being used to fill any openings in the framework. To prevent the sections pulling apart, the entire shell is either bound up securely with wire or is incased in sand. Liquid plaster of Paris is then poured in through an opening at the top and the shell filled—the interior framework serving the same purpose as the armature of the clay model. After removing the shell we have in plaster of Paris a duplicate of the original clay portrait. For proper molding in the bronze foundry it is invariably necessary that the plaster cast consist of from two to twelve or even more parts as the contour of the figure may dictate; that is, the head, one or both arms, the base, and other parts must be removable, so that they may be molded separately. This end is attained in one of two ways. When the plaster cast is made, those members which should be removable are made separately and fitted into a socket cut into the body of the figure; or else, at the foundry these members are sawed off, a protrusion is built on the end of each member and made to fit into a socket cut into the body at the point of amputation, thus forming, when assembled, a socket joint. In making the plaster cast of Lincoln (the finished bronze is shown in Fig. 11) the left arm, the right arm, the legs, and the head are all removable. In the accompanying illustrations the manner in which the various pieces are separately molded is very clearly shown.

When completed the plaster cast is then delivered to the founders, and here the requirements are so exacting that a combination of skill and patience is necessary at every step. In the foundry the molding is done in dampened sand imported from France, which is not unlike very fine clay in texture and can be packed quite hard. It has the quality of retaining the finest lines of an impression, and will neither lose them nor "burn" when in contact with molten metal. In the simplest patterns the containing box for the entire mold is made in two halves—an upper and a lower—and is known as a "flask." In the complicated molding of a statue the "flask" may consist of any number of iron sections held together by clamps, each section supporting some portion of the mold.

After separating the plaster figure into its various component parts they are dusted with soapstone. Starting with the body of the figure or largest portion, it is laid in that position which enables it to be most easily withdrawn from the sand. The molding sand is packed solidly and carried as high as the contour of the figure will permit of easy withdrawing. The surface of the sand is then dusted with plumbago or similar substance to prevent adhesion of the succeeding layer, an additional section of the "flask" put in place, sand again packed in and carried higher on the figure, as shown in Fig. 4, and so on until it is entirely covered. It invariably happens that the surface of the figure is so complex that blocks or sections of the sand have to be arranged to move horizontally away from the plaster cast when disassembling the mold. In Fig. 4 the section in front of the face is of this type. Also, the removable sections of the plaster cast are either molded separately, or put in place as the molding of the figure reaches that point, as in Fig. 7, where the head of the statue has been added.

In spite of the fact that the sand packs hard and sustains quite a weight it is necessary, when the surface of the mold is of considerable area and irregular in shape, to stiffen it with a framework of iron pieces roughly fitted over the outline of the surface and wired together as shown in Fig. 8. The sand is then packed in place and the form completed as in Fig. 9. Fig. 8 also shows the line of separation between the upper and lower molds.

After the entire plaster cast has been

Fig. 4.—Packing in sand and building up the flask.

Fig. 5.—Lincoln torso immediately after casting.

Fig. 6.—The torso after superfluous metal has been cut away.

covered or molded, it is then necessary to remove every section of the mold in order that the figure may be taken out. Since a solid casting would add both unnecessary weight and cost without in any way adding to its appearance, it is made hollow. To do this the various sections of the mold are reassembled, and as this progresses the space formerly occupied by the figure is packed with sand, forming, when completed, what is termed the "core." The same reason that applies to any other large section of the mold requires that a framework of iron with projecting ends for supporting and handling be built inside the hollow space as shown in Fig. 8. When the "core" is completed the mold is once again taken apart and the "core" removed. It is to be remembered that this entirely filled the space formerly occupied by the plaster cast figure; hence, in order to provide space for the metal the entire surface of the core is shaved away to a depth of about one quarter inch, thereby allowing this amount of space between the core and the mold, as can be distinctly seen in Fig. 9, and it is into this space that the molten metal will flow.

The projecting pieces of the iron framework of the core, which rest upon the mold body, hold the core away from the sides of the mold. These projecting pieces can be seen in Fig. 9, where they serve the additional purpose of handling the core. A vertical hole or passageway is provided, starting from the bottom of a reservoir on top of the completed mold, and connecting with numerous horizontal runways at different depths, which reach various parts of the mold so that the molten metal may reach all points of the mold as soon as possible. Some of these runways can be seen in Fig. 9.

The slightest trace of moisture in the core would become converted into steam and ruin the entire figure when the molten metal came in contact with it; hence, to avoid this the various sections of the core are loaded on a car, and carried into an oven where for 24 hours they are kept at a temperature of from 500 deg. to 700 deg. Fahr.

Then for the last time all portions of the mold and core are carefully reassembled, vents are provided for any gases generated, the sections of the "flask" are securely clamped together, a clay lined reservoir is placed on top so that a large amount of metal may be collected before it is allowed to run into the mold, and all is ready for the crucial moment when the powerful crane will lift the big iron bucket holding 2,000 pounds of molten bronze and amid pent up excitement will begin the pouring which will determine whether success or failure will crown the painstaking effort of weeks and months.

Fig. 3 shows the completed flask with reservoir all ready for the pouring. Bronze is an alloy of copper, zinc, and tin. For statuary work the mixture usually consists of 90 per cent of copper, 3 per cent of tin and 7 per cent of zinc, although the proportion of tin and zinc is varied to suit conditions. Any of several colors may be given bronze by proper acid treatment, although the natural color gives a better effect, and is generally used. When the metal has cooled sufficiently the sand is broken away from around it, the casting removed, thoroughly washed, and the core removed by washing and cutting. The figure has somewhat of an uncouth appearance, as seen in Fig. 5, in which the projecting parts of the core are seen and the runways are represented by the grapevine effect. All superfluous metal is cut away, an acid bath is given for further cleaning, and the bronze figure now has the appearance seen in Fig. 6. It is now carried to the finishing room, where all of its parts are assembled and permanently fastened in place, any seams being welded together with pneumatic hammers. After a careful inspection and retouching the statue is completed as seen in Fig. 11. It is now ready for its final resting place, where it will remain through generations to come a perpetual monument and reminder of the greatness which once helped make history.

Fig. 7.—The head of Lincoln was put in place as the molding of the figure reached that point.

Fig. 8.—Iron framework built in the core. Projecting ends are provided for handling.

Fig. 9.—The metal flows in the space between the core and the mold.

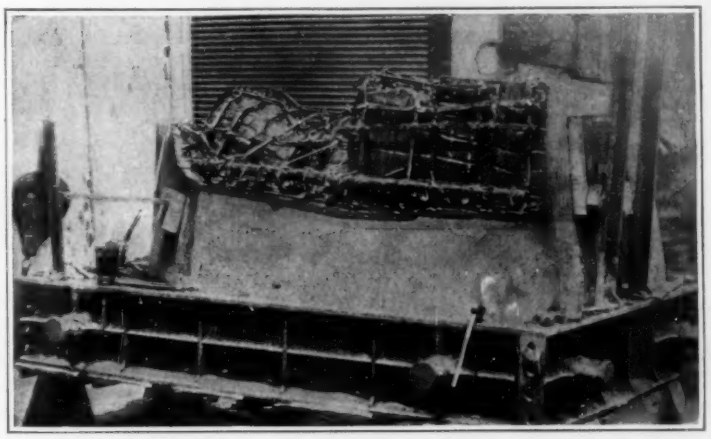


Fig. 10.—A framework of iron pieces wired together stiffens the mold.

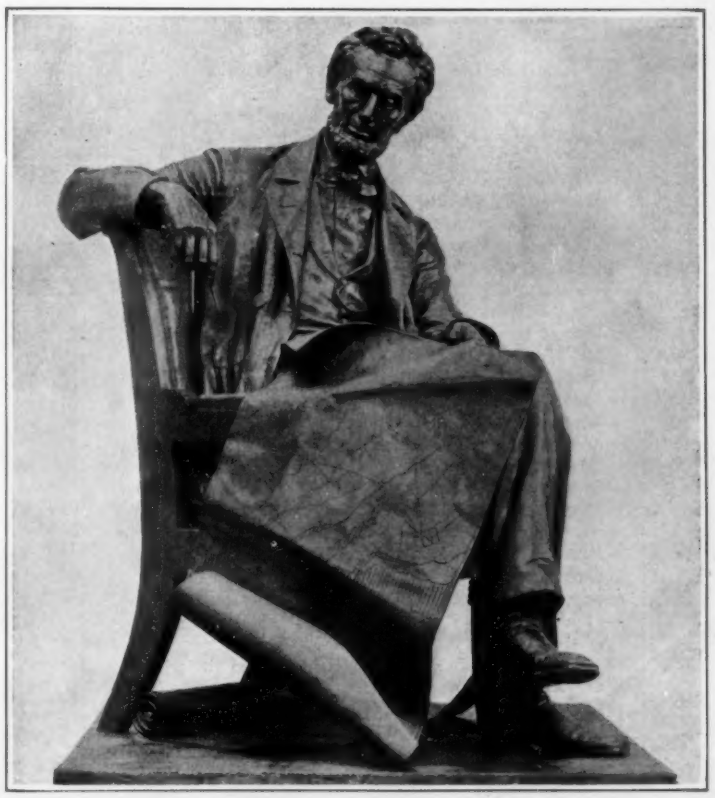


Fig. 11.—The completed statue of Lincoln.

By far the greatest number of statues are of army officers; statesmen come next; representatives of the pulpit are sometimes perpetuated in bronze; and away down the list come the navy officers. This may be because the greatest number of our important battles up to and including the civil war were fought by the army, hence the greater number of prominent officers are of the army; or it may be that we have been somewhat slow in perpetuating the memory of our none less valiant and important heroes of the navy.

Generating Current at the Mine

THE cost of power for lighting and manufacturing purposes depends generally on the cost of fuel, and the cost of fuel in most cases is determined by the freight rate, or transportation charges from the point of production of the fuel to the center at which the power is required. Successful efforts have been made in Nova Scotia to transport power in the form of electric energy from a colliery to neighboring centers, thus avoiding freight rates, or reducing these rates to an amount equal to the loss in electrical transmission, plus interest on cost of transmission line.

At Chignecto the central station is located, and the district is supplied from this point. The central station as originally equipped contained one 500-kilowatt generator, direct connected with a vertical center crank cross compound engine running at 300 revolutions per minute.

This plant was installed primarily to make a market for some unsalable refuse from the colliery, but the success met with was so marked that additional units were installed. The plant now has a capacity of 1,500 kilowatts, and is running with an overload, while plans are being prepared for installing an additional 1,000-kilowatt unit, contracts having been signed for the disposal of the greater part of this additional power.

The power station is located one hundred feet from the bankhead at Chignecto Colliery, and conveyors are so arranged that the fine culm, which passes through the screens, and crushed refuse, which is picked from the screened coal in passing over the cleaning belts, is conveyed directly to overhead storage pockets in the boiler room of the power plant. This fuel contains 23 per cent ash and is fed by gravity into mechanical stokers.

The current in transmitted at 11,000 volts, 3 phase, 60 cycle, and is utilized at Amherst, eight miles from the central station, for general factory purposes and the entire lighting of the city. At Nappan the gypsum quarries operate their derricks and pumps.

Collieries at Joggins Mines, fifteen miles from the central station, are operated mostly by electricity, and the ventilating, pumping and coal cutting machinery are all motor driven.

River Herbert is a thriving farming community, the farmers of which utilize the cheap power available to their own advantage for milking, separating, churning, etc. At the other points touched by the transmission line the power is chiefly used for lighting purposes.

This project has been brought from its small beginning to its present successful state under the direct supervision of G. B. Burchell, a consulting mining engineer of Montreal, Canada.

American University in Siam.—Under the auspices of the American Presbyterian Mission in Northern Siam a university is in process of development at Chieng Mai. It is expected to absorb the Prince Royal's College as the college of arts, in addition to which there will be faculties of sciences, medicine, and theology.

Parabolical Overhead Wiring for Electric Roads

By Owen M. de Munnick, C.E., E.E.

THE construction of overhead wiring for electric traction has undergone considerable alterations during the last few years; alterations which were to be expected owing to the great extensions of railways and tramways and to the increasing speed. The existing construction did not meet the latest requirements, and the chief factors which led to the reconstruction can be considered as the following:

I. The application of high tension alternating current for traction purposes.

II. The necessity of a minimum sag of the conducting wire at high speeds to insure an even contact of the bow (trolley).

III. The necessity for suspending the conducting wire in a non-rigid manner, due to the fact that each rigid point jars the contact bow (trolley) causing it to spark, also imparting a trembling motion to the bow (at high speeds), resulting in a series of sparks.

To meet the above requirements it was needful to provide a new means of hanging the conducting wire above the track. This was found in the catenary system, which permits of the conducting wire being suspended at short intervals and in quite a yielding manner. Such a system exists in Holland on the lines Leiden-Katwyk-Noordwyk and Rotterdam-The Hague-Scheveningen. The last mentioned line possesses the peculiarity that the influence of the temperature is neutralized by means of weights which give a constant strain to the wire. This conducting wire is, of course, suspended in a movable manner. The parabolical carrying wire, with the parallel wire above the conducting wire, as used on the New York, New Haven and Hartford Railway, are not movable; they are thus subject to the influence of the temperature, lengthening and sagging in hot weather and shortening with increased stress in cold.

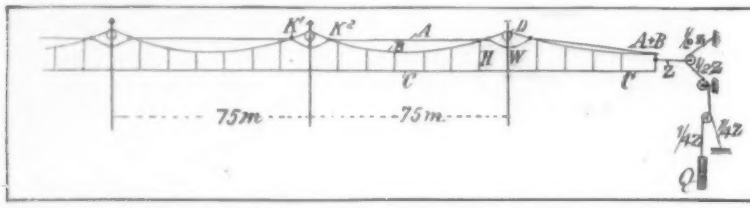
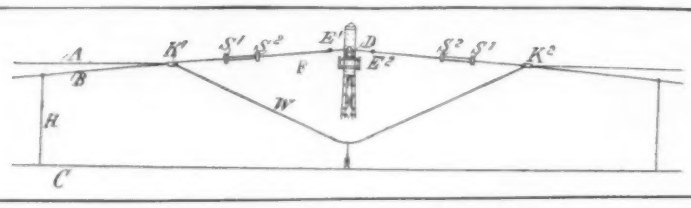


Diagram showing the method of straining the cables so as to prevent sag.



Detail of the support at one of the bridges.

To avoid this drawback a system was contrived by the A. E. G. Company, by which all wires are made movable.

During a number of years they have made different trials along these lines on their experimental railway at Oranienburg, and have succeeded in constructing a system that was adopted by the Prussian State Railways. In 1910 the line Dessau-Bitterfeld (steam railroad) was partly equipped with this system, the other part being carried out by the Siemens-Schuckert Company (the same system as the Rotterdam-The Hague-Scheveningen, which was constructed by the same [S. S. W.] company).

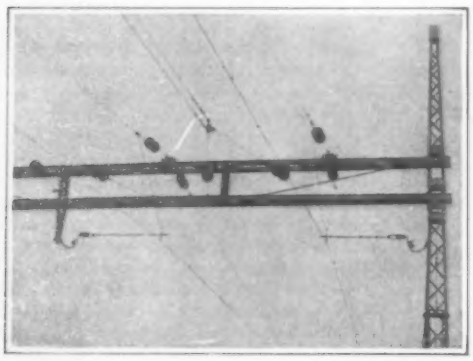
Dessau-Bitterfeld is only a trial line, as plans are made to electrify the whole steam road from Magdeburg, Leipzig and Halle. This extension will be very important, as the newly constructed part is only 27 miles long and rather too short for making long-distance trials at high speeds.

In the accompanying drawings of the A. E. G. system, showing three spans of the overhead line and the method of suspension on a cross girder, A is the strain wire, B parabolical suspension wire, C conducting wire, H vertical suspension wire, K_1 and K_2 are clutches, W is the loop formed by A and B passing below the cross girder, F is a flexible wire to which the insulators S_1 and S_2 are attached. This wire connects the clutch K_1 with K_2 and brings the strain over from one side to the other, as the loop W is hanging loosely. This flexible wire F is insulated between the insulators S^1, S^2 and rests on the diabolo insulator D on the cross girder. Two notches E_1 and E_2 are fixed on each side of the insulator D, which prevent the flexible wire F from moving too far to the right or left, under the influence of the temperature. Galvanized clutches are used to join the wires together where necessary, as no connection was made by soldering.

The insulators are so made that in case one of them breaks the whole system cannot fall, as the two wires are looped inside the insulator. The strain wire A is provided to assure a regular stretch of the parabolical carrying wire over the whole length from the fixed point to the weights. This strain wire, of course, has very little sag. The clutches K_1 and K_2 join the strain wire and the parabolical suspension wire at each suspension point on the mast, bringing their strain over on the flexible wire F. The loop formed under the cross girder by the two first mentioned wires is necessary in case an after regulation of one of the wires is needful. The working of the system is as follows:

When the temperature is increasing, the parabolical carrying wire B will expand, thus increasing the sag, or in other words decreasing the strain. The strain wire A will expand to about the same extent, being made of the same material (galvanized steel cable). Its strain will also decrease; and, as it has very little sag, its strain will decrease considerably more than that of the parabolical wire. The weights at one end pull with a constant strain, and thus stretch both wires until the strain is balanced, when the drops will be exactly the same as before; since for a certain constant strain there is always a certain constant drop. By a decreasing of the temperature an opposite action will take place. The same happens to the conducting wire, as it is also connected to the same weights at the end. Near these weights is a lever P, to which the three wires are joined, and a flexible wire bringing their stresses over to weights on the mast. This lever is necessary because the strain wire and parabolical wire are made of steel, while the conducting wire is made of hard bronze. These have different temperature coefficients, which this lever neutralizes.

To start the building up of the system little hooks are fixed to the masts at *each side of the railroad (about two meters above the ground)*. On these hooks provided with wheels the flexible wire F (already fitted complete with the insulators and clutches) is laid, and the strain wire and parabolical wire are fixed to this flexible wire and the required drop of both wires regulated. This drop can be measured by means of a dynamometer (measuring its strain), but it is easier and quite exact enough to find it in the way described below. A little wooden post is erected in the middle between the two masts; three movable hands are fitted to this post. The top one is level with the disk on the mast, the other two hands giving the theoretical drop of the two wires. When this is finished complete section from one pair of weights to a new pair (distance of about 1,000 meters), is ready. The vertical suspension wire can also be fitted. The conducting wire is hung on these wires (after being stretched on half its normal strain). When the whole system is ready it is pulled up by block and tackle over the whole length of one section and placed on the diabolo insulator in the center above the track. It is always necessary, of course, to inspect the system after it has been placed in the proper place, by means of a tower wagon.



Details of one of the bridges, showing method of straining the cables.

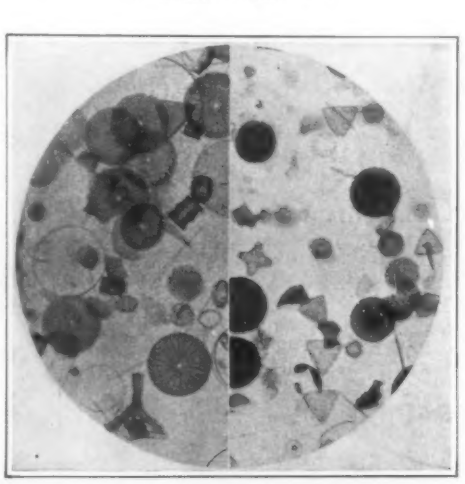
Constructing the line at the ground before hoisting in place.

A Comparison Microscope

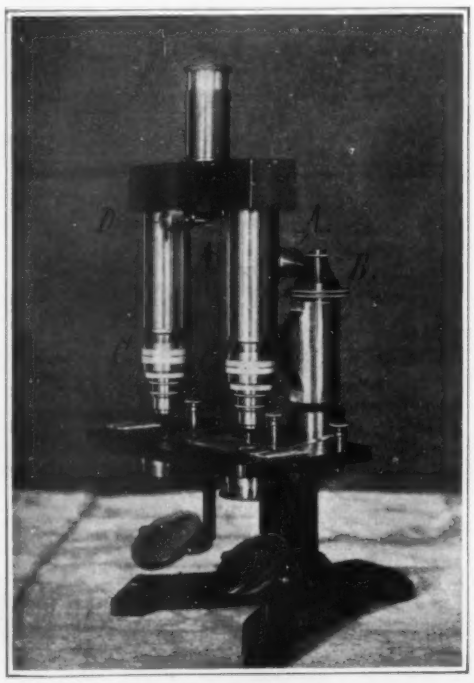
By Dr. Wilhelm Thoerner

THE manifold demands and wishes of workers in every field of scientific and medical research have been met by instrument makers, very successfully, as a rule, by improvements in the mechanical and optical construction of the microscope and its accessories. It is the more remarkable, therefore, that no instrument has come into general use for the simultaneous observation and direct comparison of two microscopic objects. Such an instrument, which may be called a comparison microscope, would render very valuable services in a great many scientific investigations. In testing articles of food, for example, it would often be

(Concluded on page 160.)



Comparison of two specimens of diatom plankton.



A comparison microscope.

The Mono-rail Sled

A NEW type of sled has put in an appearance recently which should delight the heart of every small boy. The object which will first catch his eye is a steering wheel, a real live steering wheel, just like that of an automobile, and it controls a steering runner placed in advance of the two main runners. But even more interesting than that is a fourth runner placed between the main runners. Ordinarily this does not come into play. But after the young coaster is well started down the hill he pulls the steering wheel toward him, depressing this fourth runner, and raising the entire sled upon it, so that he continues to glide down hill on two runners, arranged in tandem. This reduces the friction surface, enabling him to outstrip his rivals on the more clumsy type of sled. A certain amount of skill is required to maintain the balance on the center runner, so that the sled will run like a bicycle, and this adds interest and excitement to the sport.

Turbine Casting for the Gatun Power House

THE accompanying illustration shows one of the three turbine castings recently made at Hartford, Connecticut, for the power house at Gatun, Panama. The turbines will take water from the great lake formed by the Gatun dam and will drive electric generators to supply the power for operating the gates and towing the vessels through the locks and also for lighting the Canal Zone. The turbines will have to develop 3,600 horse-power. The castings are made of a composition of copper, tin and zinc, in the proportion of 88, 10 and 2. The alloy is required to show a tensile strength of 30,000 pounds, an elastic strength of 15,000 pounds, and 18 per cent elongation. The castings weigh a little under 7,500 pounds. It will readily be appreciated upon examining the illustration that some very intricate dry sand core work was necessary to produce these wheels. The vane cores, of which there were sixteen for each of the three wheels, weighed a little under 700 pounds each, and because of their peculiar shape, they were exceedingly difficult to set.

Benvenuto Cellini's Portrait of Himself

THE rear of the helmet of the famous statue of Perseus at Florence is cleverly designed to represent a face, with a beard formed by the curling hair beneath. Although this face has been known to exist for some time, no attention has been paid to it. Recently, however, an antiquarian named Annibale Benedetti discovered the face, and was struck with its marked resemblance to Benvenuto Cellini, who made the statue. It is a curious fact that no reference to the portrait is found in the state archives or in any of the descriptions of this piece of work, nor even in Cellini's own memoirs of his masterpiece. The statue was ordered by Cosimo di Medici; and the theory has been put forth that being jealous of the glory that might come to Cellini, he would not permit the sculptor to place his name upon the statue. On the other hand, Cellini being a very vain man, could not give to the world this masterpiece, which took him nine years to complete, without identifying himself with it in some way. Hence, he adopted the daring and novel expedient of actually carving his own likeness upon the statue, so that for all future time there would be no doubt of its authorship.

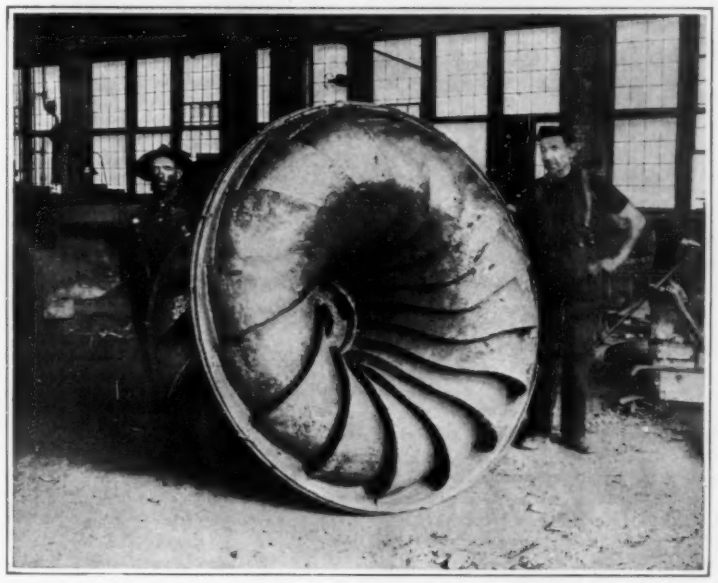
The Sleigh of the Desert

A CORPORAL in the French army in North Africa has devised a peculiar machine particularly adapted for travel over the sand wastes of the Sahara. The machine is a cross between an automobile and an aeroplane, and has been dubbed the "sleigh of the desert." The construction is very light indeed. It is mounted on broad-tired pneumatic wheels, but is driven by an aeroplane propeller. It is so light and its bearing surface is so great that it will ride over the sands without sinking, leaping over light depressions and climbing the steepest sand dunes. There is a decided advantage in using an air propeller, for then the drive of the machine is independent of its traction. In the loose sand of the desert it would be rather difficult to propel a machine after the manner of an automobile. The accompanying photograph, which is published by courtesy of *L'Illustration*, shows the odd machine upon its arrival at Toujourt, having carried Gen. Bailloud over a distance of about 120 miles. The peculiar vehicle is named "La Sauterelle," or the grass-hopper, because of its peculiar hopping flight over the irregularities of the desert.

Readers are invited to contribute photographs of novel and curious objects, unique occurrences and ingenious contrivances. Such as are found available will be paid for promptly.

A "mono-rail" coaster.

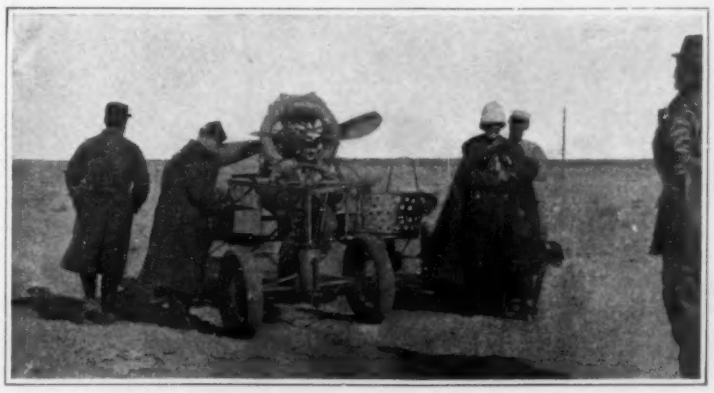
Balanced on tandem runners.



Intricate turbine casting for the Gatun power house.

By courtesy of the *Sphere*.

Portrait of Benvenuto Cellini, discovered on the helmet of his famous statue of Perseus.



The "grass-hopper" coach of the Sahara.

Fish Killed by Frost and Storms

IN *Symons's Meteorological Magazine* Rev. D. C. Bates, dominion meteorologist of New Zealand, tells of some curious effects of atmospheric disturbances on fish. A deep-sea species known as the "frost-fish" (*Lepidopus caudatus*) is found lying dead on the shores of the South Island of New Zealand during and after severe cold weather. It is a long ribbon-like silvery fish of delicious flavor, and men scour the sands at night to find it. These fish rise from very great depths and apparently are killed by the bursting of their air-bladders rather than by the cold; yet their coming to the surface seems to be connected with the weather, especially with anticyclonic conditions.

After severe storms the coasts of New Zealand are often strewn with tons of dead fish, of many species. A correspondent of the author writes in regard to such an occurrence at Island Bay, Wellington, on July 18th, 1912: "This is not the first time, nor the tenth time, that fish have been landed on the shores of Cook Strait in precisely the same fashion, in every case subsequent to a storm. Therefore, we must look for the cause in the storms, unless it is that storms may produce what we call fumes, by stirring up the bottom of the sea. Immediately offshore we have comparatively deep sea, inhabited by fishes which are not usually met on the immediate coast-line. If from any cause during a high storm deep-sea fishes hug close to the land, then it only requires a very heavy sea, in which waves strike the bottom, to involve the fish, rush them ashore, and kill them by hundreds."

After the storm of July 18th, mentioned above, great quantities of the dead fish —ling, hapuka, hake, etc.—were gathered and brought into Wellington. On another occasion, some thirty years ago, the beach at Okarito, on the South Island, was strewn for seventy miles with fish of all sorts and sizes.

How to Wax Old Unpolished Floors

TO wax old floors that were never polished the following method is good: The floors should first be washed thoroughly, and then when dry coated with some floor oil such as linseed oil. This should be at once rubbed with sawdust, which removes all surplus oil and polishes the floor. After this any wax may be used according to its directions, and then after a weighted brush is used the old floors will be as slick as new oaken floors. After this they should only be washed with gasoline.

A Bill Providing for a New Patent Office

ON January 17th, 1913, Mr. Bulkley introduced a bill providing for the construction of a Patent Office of the United States. The sum of $4,000,000 is to be appropriated out of any money in the Treasury not otherwise appropriated for the erection of a fireproof building. It is very doubtful if the bill will be taken up during the present session. Everyone at all familiar with present conditions in the Patent Office will recognize the necessity of the new building.

Inventions New and Interesting

Simple Patent Law; Patent Office News; Notes on Trademarks

Recent Improvements in Machine Tools—II

[IT has often been said, and rightly so, that the perfection to which metal working has attained is one of the miracles of modern times. In many factories throughout the country the various pieces are turned, milled, sawed, planed, or ground in such quantities, at such speeds and with such unfailing accuracy as to command the admiration of the observer. Yet in spite of this perfection there always seems to be room for further improvement. This is the second of a series of brief articles on recent improvements that have been made in machine tools.—EDITOR.]

IN bevel gear cutting machines it has long been the custom to tilt the cutter carriage to the proper angular position desired.

The disadvantage of this proceeding has been that such a structure lacked the proper rigidity for heavy cutting—a disadvantage which has been particularly noticeable since the advent of high speed steel cutters. This lack of rigidity is due to the mounting of the reciprocating cutter carriage upon the angularly adjustable slide and the circuitous route by which the motion is transmitted from the primary mover to the cutter spindle and feed screw.

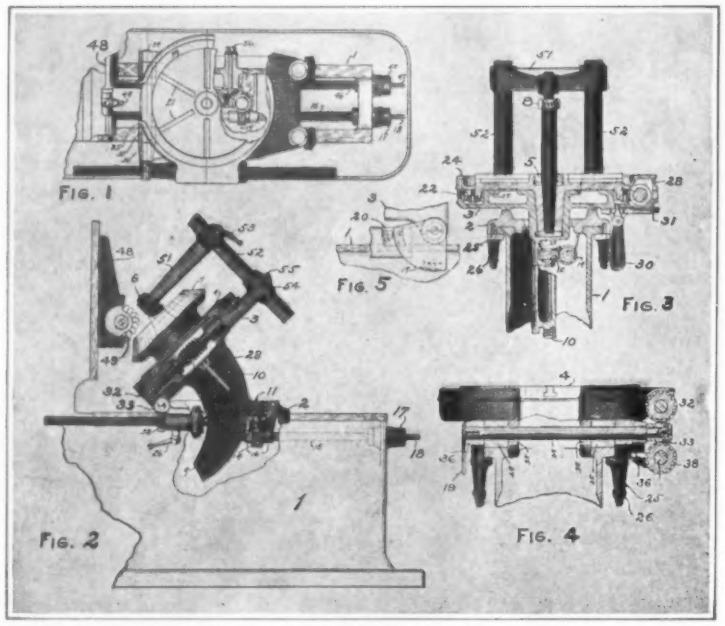
A recent patent granted to W. F. Zimmerman of Newark, N. J., shows a marked commercial advance in the art of cutting bevel gears. Instead of tilting the cutter carriage, the patentee provides a work table which is capable of being tilted to the proper angle. This table is so constructed that the strains imparted thereto by the cutter are taken by a base of rigid construction.

The advantages of this device are at once apparent. In the usual constructions where the cutter is adjusted, there are three sliding surfaces necessary—two for the cutter and one for the work table. But by adjusting the work table, only two sliding surfaces are required—one for the cutter to reciprocate thereon and one for the work table. Then, too, a less complicated drive necessary to rotate and feed the cutter is required. It also eliminates the additional means required to control the reciprocating movements of the cutter slide and the indexing of the blank, the index drive being practically the same as usually found in ordinary spur gear cutting machines.

As seen in the figures, an adjustable slide 2 is provided with clamps, 25, operated by handles 26 so that the slide 2 can be firmly secured to the frame 1. Hinged to one end of the slide 2 is a tilting bed 3 having rotatably mounted therein a work table 4. A work arbor 6 is secured in this work table by means of a differential nut 5, and centers the bevel gear blank 7. Depending from the center of the tilting bed 3 is a segmental arm 9 having a worm wheel segment 10. This arm is secured to the slide 2 by means of a bolt 56, its outer periphery being rigidly clamped by means of a clamp 57 to a finished portion within the aperture of slide 2, through which the arm passes.

The tilting bed 3 and the bevel gear blank 7 are adjusted to the proper angular position by the worm 11, rotatably mounted in the slide 2, engaging the worm wheel segment 10. On one end of the worm 11 is a helical gear 12, held in position by means of a nut 13, which engages with a helical gear 14. This gear 14 is slidably keyed upon and rotates with the splined segment adjusting shaft 15, and is held between the bearings 16 in the slide 2. The forward end of the segment adjusting shaft 15 projects beyond the frame 1 and is provided with a graduated dial 17 and a square end 18 to receive a crank handle. The ratio of the worm wheel segment 10 and worm wheel 11 and helical gears 13 and 14 is such, that for each turn of the segment adjusting shaft 15, the bed 3 is adjusted one degree, indicated by the dial 17 graduated to read in minutes.

As seen in Fig. 5, a graduated segment 19, reading in degrees, is secured to the bed 3 in connection with a vernier scale 20 reading in tenths of a degree, to indicate the exact angular position of the work at all times.



In this bevel gear cutting machine, a distinct improvement has been effected in machine tools. Instead of tilting the cutter carriage, the patentee provides a work table which is capable of being tilted to the proper angle.

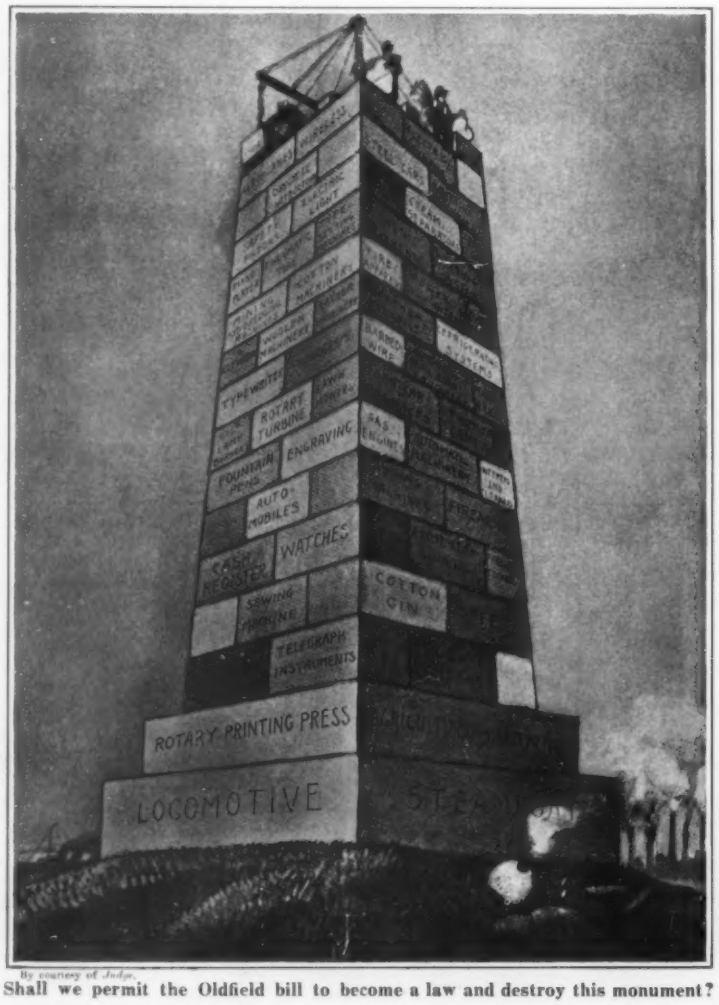
The work table 4 is rotatably mounted in the bed 3 and is provided with T slots 21, to secure the blank to the table. The index wheel 22, which rotates the work, is arranged upon the periphery of the work table 4. The work table 4 is supported near the outer periphery by a circular bearing 23, arranged in the bed 3, and is held thereto by a circular plate 24 secured to the bed 3. This plate 24 is provided with a circular groove to form a channel for the cuttings and the lubricant to lead them into the base of the main frame. The plate 24 also serves as a guard to protect the index wheel from chips and dust.

The index wheel 22 is rotated by an index worm 27, rotatably mounted in an adjustable bearing 28 on the bed 3. The bearing 28 is adjusted toward or away from the index wheel 22 by means of the handle 30. A stop-screw 31 is provided in the bearing 28 to gage the depth of engagement of the worm 27 and wheel 22. A helical gear 32, engaging with a second helical gear 33, is mounted on one end of the index worm 27. The gear 33 is loosely mounted upon the hinged shaft 34, passing through the lugs 35 and 36, and the lug 37 between the lugs 35 and 36 is supported by the ways of the main frame 1. The helical gear 33 is rotated by a helical gear 38, rotatably mounted in a bearing of the slide 2. This arrangement of helical gears provides for transmitting a rotary motion from the helical gear 38 to the index worm 27, independent of the angular position of the worm 27, and for the disengagement of the index worm 27 from the wheel 22 in all the angular positions of the worm 27.

The cutter carriage 48 with rotary cutter 49 is reciprocated vertically by well known means.

When the work has been adjusted to the proper angle, the slide 2 is adjusted longitudinally toward the cutter carriage 48 by means of the screw 46, the end 47 of which is adapted to receive a crank handle. The amount of adjustment is indicated by the dial 50 graduated to read in thousandths of an inch. After the work is secured to the mandrel 6 by means of the nut 8, the projecting end of the mandrel 6 is supported by a triangular arm 51, slidably arranged upon two posts 52 and clamped thereto by means of the handles 53. The posts 52 are slidably mounted in the bearings 54, provided in the bed 3, and are clamped to the bed 3 by means of the bolts 55.

(To be continued.)



By courtesy of *Judge*.

Shall we permit the Oldfield bill to become a law and destroy this monument?

The Oldfield Bill Cartooned

THE accompanying cartoon, reproduced by courtesy of *Judge* from the columns of that weekly, tells its own story. Readers of the SCIENTIFIC AMERICAN who have followed the attempt to pass a measure which cannot but have a destructive effect upon our patent system, and which must inevitably discourage invention, will appreciate the graphic truth of the cartoon. *Judge's* title for the picture, evidently inspired by a resolution addressed by the Inventors' Guild of New York city to President Taft, read:

"Invention has contributed the greatest blessings of civilization, and for America has laid the ground work of our wonderful industrial prosperity. The American patent law, by its liberality to inventors, has fostered the inventive faculty and made us the foremost inventive people. If we value future progress and continued prosperity, we should change our patent laws only after the most scientific and searching study, and only upon the most conclusive grounds."

A Non-refillable Bottle.—In patent No. 1,046,757, to Charles C. Fine, assignor of one half to Jacob W. Fine, both of Nanticoke, Pa., is shown a bottle in which there is provided a longitudinal passage parallel with the neck outlet and opposite said passage is another longitudinal passage communicating with it through a lateral opening and a second longitudinal passage contains a ball which controls communication with the interior of the bottle to prevent refilling and may be unseated to permit the contents of the bottle to be dispensed.

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PENNSYLVANIA RAILROAD

RECENTLY PATENTED INVENTIONS

These columns are open to all patentees. The notices are inserted by special arrangement with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

Pertaining to Apparel.

BELT BUCKLE.—M. GREENFELD, care of Ralph B. Ittelson, 170 Broadway, New York, N. Y. The invention relates to improvements in buckles, and particularly to belt buckles, and has for an object the provision of an improved catch or interlocking structure adapted to be readily engaged and disengaged, but firmly held in place when engaged.

GARMENT STIFFENER.—ROXANNA A. HAMPTON, 23 W. 24th St., Manhattan, N. Y., N. Y. This stiffener is more especially designed for stiffening the yokes of ladies' dresses and waists, such as open along the back, and arranged for convenient insertion in the yokes and sufficiently pliable to readily conform to the shape of the wearer, with a view to give the desired stiffness to the yoke without rendering the garment uncomfortable.

Of Interest to Farmers.

YOKE.—J. LLOBET and J. GIMENEZ, Calle Colon, No. 2, Habana, Cuba. For the purpose of enabling an animal to more easily carry a load attached to a yoke, use is made of a main stem adapted to turnably engage the shaft or tongue of a vehicle, a main bearing body mounted to swing on the main stem, auxiliary bearings on the main bearing body, and head bows mounted to swing on the auxiliary bearings.

Of General Interest.

FENCE POST.—B. F. CARPENTER, Bandon, Ore. The invention provides a one-piece post, which may be driven directly into the ground and which does not require tamping. Also provides a post with means for holding the fence wires securely, but in uch a manner that they may be released from the post when desirable.

PLANT PROTECTOR.—W. G. COWART, Nocatee, Fla. This protector is formed of fixed and movable parts consisting of panels and supporting stakes. A series of oblong panels is supported in fixed position, inclined, say, 30 degrees to the vertical, by means of stakes set in the ground and inclined in opposite directions, their upper ends or heads being connected with the top or ridge bars of the panels, the latter being placed near and parallel to the row of plants needing protection. Another portion of the protector is composed of a series of adjustable panels, and a third series may be employed and adapted to extend over the plants, or fully folded back for exposing the plants. Mr. Cowart has invented another protector formed of two oblong panels secured together rigidly at an angle to each other, whereby the device is adapted to be applied over and protect plants, and with means for supporting the protector when turned on its side, so that it is held constantly in position for replacement over the plants.

COMPOSITION OF MATTER TO BE USED AS A FLEXIBLE COVERING.—F. M. RUSCHHAUPT, care of W. O. Faist, Am. Flexible Slate & Covering Co., Milwaukee, Wis. This invention relates to a covering material to serve as a substitute for slates, tiles and other forms of water and acid-proof coverings and linings. An object of the inventor is to provide a flexible covering impervious to acids and alkalis, of a water-proof and air-proof material for use as a roof covering or in any locality where it is desired.

DEVELOPING TUBE.—J. E. WALLACE, Varna, Ill. The invention provides a means whereby photographic films may be developed in daylight. The device is convenient for carrying without liability of injury. Developing means is provided that may be conveniently manipulated, and which will insure that the film is effectively subjected to the developing fluid.

FLEXIBLE SLED.—J. C. MINISH, Ridgway, Pa. An object here is to provide a device which is more easily manipulated than the ordinary flexible sled in that it has greater leverage upon the flexible runners. It costs no more than the ordinary sled for rendering the present flexible sled more susceptible to guiding influences.

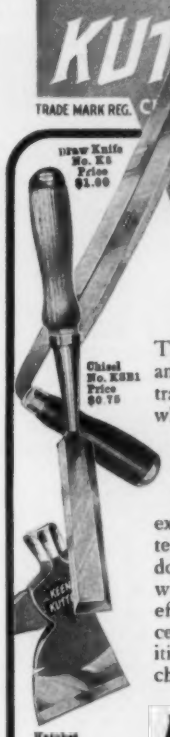
LIFTER AND CONVEYER FOR INVALID BEDS.—J. GERMAN, Richland Center, Wis. This invention relates more particularly to the combination of a bed, an auxiliary support adapted to be positioned upon the bed to receive the patient, and means for moving the support in a plurality of directions and for removing it entirely from the bed to a point remote from the same, the means serving to hold the support in different operative positions when it is removed from the bed.

DRY CARTON.—A. TAYLOR, 15 E. 42nd St., New York, N. Y. Among the principal objects which the present invention has in view are, to provide means for preventing injury to articles by moisture while in storage or transportation, and to provide a simple, efficient and economical means for deleting the moisture from cartons or other such devices. The cartons may be used for holding tennis balls, cigars, candies, and a wide variety of other materials.

DRINKING CUP.—C. A. BRYANT, Passaic, N. J. This cup is made of paraffine paper in

E. C. SIMMONS KEEN KUTTER

TRADE MARK REG. CUTLERY AND TOOLS U.S. PAT. OFF.



Tools with a Pedigree

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KEEN KUTTER Tools

that the line has become almost world-famous. Tool-wise mechanics no longer pass thumb along the edge of hatchet, draw knife or chisel to test its keenness, nor do they heft and swing a hammer or axe to learn its "hang." They simply look for the trade mark and when they see it, buy. *You,* too, can be as sure of good tools as these men, if you follow their certain way of selecting. But, if by any chance a tool you buy, bearing our trade mark, should show a flaw or develop a defect, your dealer is instructed to refund your money. *That* is the Keen Kutter guarantee.

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Rumely Bulletin No. 11

This Trademark Means Farm Efficiency

This Trademark is well known to the 6,400,000 American farmers. It has appeared in farm papers many millions of times in the past 60 years.

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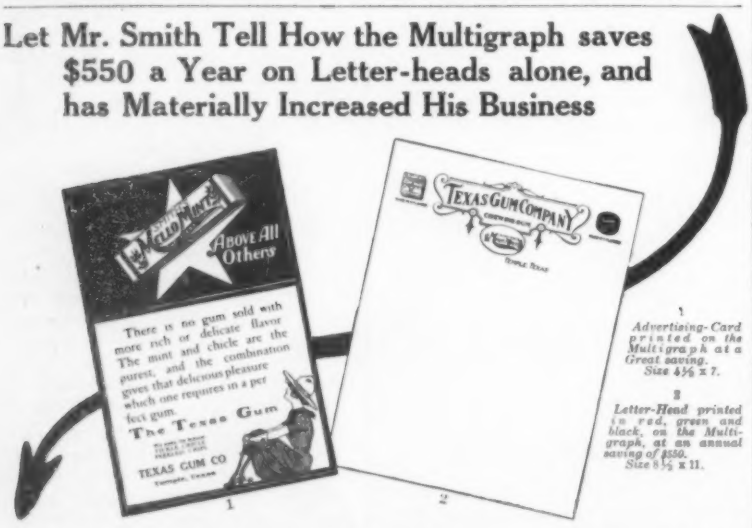
385

Let Mr. Smith Tell How the Multigraph saves $550 a Year on Letter-heads alone, and has Materially Increased His Business


Above All Others
There is no gum sold with more rich or delicate flavor. The mint and chicle are the purest, and the combination gives that delicious pleasure which one requires in a perfect gum.
The Texas Gum
TEXAS GUM CO.
TEXAS GUM COMPANY
1
2

1 *Advertising-Card printed on the Multigraph at a Great saving. Size 4½ x 7.*

2 *Letter-Head printed in red, green and black, on the Multigraph, at an annual saving of $550. Size 8½ x 11.*

Here's Mr. Smith's Own Statement in a Letter to Us:

"THE Texas Gum Company started business in a very small way, and up to the time we installed our Multigraph we had not undertaken any extensive advertising campaign; but since the installation of an Electric Printing Multigraph we have been enabled to carry on quite an active advertising campaign continually, which has been the means of a very material increase in our volume of business. We would under no consideration consider being without the use of the Multigraph in our office."

"As to the actual saving in the cost of work done on the Multigraph compared with having it done by job printers, we offer the following as an example."

"We run a letter-head printed in three colors, which formerly cost us $4 per thousand. We are now printing this on our Multigraph at a cost of $1.25 per thousand. As we use 200,000 letter-heads in a year, the saving on our letter-heads alone amounts to $550 annually."

"We are enclosing a large number of forms that we print on the Multigraph, and we can say frankly that this printing is just as good as the work that we formerly got from the printer; and a young man in our office produces it without any trouble."

TEXAS GUM COMPANY
Temple, Texas. B. F. Smith, Pres.

(Mr. Smith tells us he will be glad to answer any inquiries.)

You Can't Buy a Multigraph Unless You Need It

BUT one of our representatives will gladly help you ascertain your need. Begin your investigation today. Get in touch with our nearest branch; or write us direct, on your business stationery, for specific information.

USE THE COUPON.

What Uses Are You Most Interested In?

Check them on this slip and enclose it with your request for information, *written on your business stationery.* We'll show you what others are doing.

AMERICAN MULTIGRAPH SALES CO.
1822 E. Fortieth St., Cleveland

Printing:
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- ☐ Envelope-Stuffers
- ☐ House-Organ
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- ☐ Label Imprints
- ☐ System-Forms
- ☐ Letter-Heads
- ☐ Bill-Heads and Statements
- ☐ Receipts, Checks, etc.
- ☐ Envelopes

Typewriting:
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- ☐ Booklets
- ☐ Envelope-Stuffers
- ☐ Price-lists
- ☐ Reports
- ☐ Notices
- ☐ Bulletins to Employees
- ☐ Inside System-Forms

THE MULTIGRAPH

Produces real printing and form-typewriting, rapidly, economically, privately, in your own establishment

You don't need to print 200,000 letter-heads a year to find the Multigraph profitable. There are many ways in which it would doubtless increase your business and cut your printing costs, whether your business is small or large.

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European Representatives: The International Multigraph Company, 59 Holborn Viaduct, London, Eng.
Berlin, W. 8 Kranzeckstr., 70 Eckr Friedrichstr. Paris, 24 Boulevard des Capucines

the form of the frustum of a cone and is made of a single sheet of paper doubled up and having the sides connected with each other, the bottom being flat and upon which fold ears fastened in place by a separate strip glued thereto and overlapping the ears.

LOCKET.—J. NEDERLAND, 276 Fifth Ave., Brooklyn, N. Y. To provide a hinged frame shaped to prevent buckling when the locket is made of light material, to provide a hinged construction shaped to the contour of the locket, to provide a frame for the locket having the glass and picture frame formed integrally therewith, to form an interior snap integrally constructed from one portion of the frame to engage the other portion; such are the principal objects of Mr. Nederland's invention.

CHANGE LETTER SIGN.—W. ELLISON, Roosevelt, N. Y. The invention consists in securing between overlaying areas of open mesh wire gauze opaque letters assembled and arranged to form a reading sign, the contrast between the opacity of the letters and the transparency of the gauze imparting an aerial and unsupported appearance to the sign. A simple means is provided for binding the overlayed gauze on the interposed letters.

SAFETY BOTTLE HOLDER.—T. ZABRENAS, care of A. M. Marters, 120 Grand St., Brooklyn, N. Y. This holder is arranged to permit the milkman readily to place a bottle of milk therein and prevent unauthorized persons from removing the bottle surreptitiously from the holder. The holder is provided with a sliding cover which may readily be opened by the milkman, but which is locked in closed position by the introduction of the bottle.

DESK PAD.—E. OLDENBUSCH, care of Kronheimer & Oldenbusch, 366 Butler St., Brooklyn, N. Y. The present invention relates to desk-pads and more particularly to a corner plate for desk pads so constructed that in addition to performing its usual functions of confining a corner of a sheet of blotting paper, it may also be used as a receptacle for small cards and other articles.

BURIAL VAULT.—J. BERMEL, 2210 Metropolitan Ave., Middle Village, L. I., N. Y. The object of the present invention which relates to a previous patent No. 983,804 is to provide an improved vault arranged to accommodate one or a plurality of bodies and to protect the latter from vermin by providing hermetically sealed catacombs or compartments, one for each body, these compartments being practically airtight and waterproof.

COMBINED TABLE AND MAP RACK.—K. W. SCHWARZ, 615 Center St., Little Rock, Ark. The invention consists of a table with a box supported under the table top. In the box is a rotating cylindrical casing, provided with a number of rollers for accommodating any desired number of maps. The maps may be drawn out of the cylinder, and through a slot in the table top, and spread out upon the table.

BLOTTER HOLDER.—J. L. HAYES, care of Lee Hayes, P. O. Box 1375, Butte, Mont. The holder is made of resilient material with flanges at its ends for holding the blotter against the body of the holder, and with the central portion of the body formed in a spring loop which serves as a handle, and also as means for holding the flanges yieldingly in position.

TRUSS.—J. T. HAILE, Utopia, Tex. The aim is to provide a truss, arranged to permit in placing the pad into any desired position, securely holding it therein to prevent irritation of the body, and to render the pad pliable and at the same time maintain the uniform pressure on the afflicted part.

STREET SIGN.—J. STRACHAN, 334 36th St., Brooklyn, N. Y. The principal object here is to provide a sign having means thereon whereby it may be secured in position on the sidewalk, the construction and arrangement being such that portions thereof are protected from injury by the wheels of passing vehicles.

NAIL STRIPPER.—C. F. SMITH, 412 E. 16th St., Los Angeles, Cal. In this device different sized nails may be inserted, the nails automatically alfning themselves so that they may be withdrawn heads up. This is obtained by positioning within a suitable casing, an inclined hopper from which the nails are fed in grooved tracks, from which they may be readily withdrawn in assembled order.

Hardware and Tools.

HANDTOOL.—B. MORGAN, Newport, R. I. Mr. Morgan's improved handtool may be used as a clamp or as a spreader and stretcher for coil springs or as a valve lifter. It consists of a screw rod bearing two jaws, one fixed and the other movable upon the rod, a lever and ratchet mechanism being provided for this purpose.

TELESCOPING POCKET RULE.—F. C. GREATHEAD, 1335 Weton St. (rear), Denver, Colo. This telescoping pocket rule is of simple construction and arranged to hold compactly and yet may be extended or folded with the use of but one hand. It is made of a number of telescopic sections provided with enlarged rear portions having sliding engagement with the following sections and having a contracted front end for the enlarged rear end of a preceding section to abut against.

PIPE-WRENCH.—J. A. OVERLANDER, 535 Beacon St., Boston, Mass. This pipe-wrench

PATENT ATTORNEYS

PATENTS

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RAILROAD MEN ATTENTION.—Patent on one of the best Moveable Car Buffers for sale, No. 1,022,263. Illustrated circular on application. Address: Ph Grefflin, Waverly, Iowa, or H. G. Green, 105 W. Monroe St., Chicago.

PATTERN LETTERS

PATTERN LETTERS AND FIGURES. White Metal and Brass, for use on patterns for castings. Largest variety, prompt shipments. Send for catalog. H. W. Knight & Son, 92 State St., Seneca Falls, N. Y.

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On Little Androscoggin River, Snow Falls, Maine—7 acres land—3 buildings, viz., 30 x 40 three stories—40 x 70 two stories—33 x 100 three stories. Grand Trunk R. R. runs directly through property with side track. 45 feet fall. 500 horse power. 115 H. P. turbine and main shafting in place. 125 square miles drainage area. Water never fails. Can be purchased very low. For full particulars address J. E. Worcester, Atty., 95 Milk St., Boston.

INQUIRY COLUMN

Inquiry No. 9287. Wanted to buy a machine which will reduce cobs to meal—not a machine for shredding the cobs, but a machine that will pulverize them.

Inquiry No. 9288. Wanted the names and addresses of concerns that can coat steel balls with pure tin one-sixteenth of an inch thick.

Inquiry No. 9289. Wanted substance melting at 225° and hardening when cold without imparting any flavor to tobacco smoke and without emitting any oil or fatty vapor.

Inquiry No. 9290. Wanted name and address of a manufacturer of a patented device which is suitable for making up pay envelopes, namely, to fold up bills and insert them with minor coins in a pay envelope of the usual size.

Inquiry No. 9291. Want to buy machinery for manufacturing wooden tooth picks.

Inquiry No. 9292. Wanted a gum that will stick labels to grape-fruit.

Inquiry No. 9293. Wanted the names and addresses of manufacturers of waterproof cloth, also samples of such cloth.

Inquiry No. 9294. Wanted to buy glass balls 1⅜ x 1¼" in diameter.

Inquiry No. 9296. Wanted name and address of some glass manufacturing company who can make patent lamps.

is an improvement in the type comprising a fixed jaw and a moveable or sliding jaw, the latter being formed integral with the shank, which slides in the handle and is provided with a screw thread to which a portion of the handle constructed as a nut is applied for the purpose of adjusting the movable jaw. The fixed jaw has an inwardly inclined face and the adjustable jaw is formed with a V-shaped toothed biting surface.

Heating and Lighting.

GAS GENERATOR.—M. DAVICION, 46 Rue de Chateaudun, Paris, France. In the present patent the invention has reference to improvements in gas generators and has for its object the provision of a gas generator the vat of which is so suspended as to keep the approaches of the hearth completely clear.

FLUE CLEANER.—G. C. FRENCH, Eldora, Iowa. This invention refers to cleaners for freeing the flues of boilers and other apparatus from accumulations of soot, scale and the like, and has reference more particularly to a flue cleaner which comprises an elongated flexible body having an adjustable scraper mounted thereon.

PORTABLE CREMATING CLOSET AND GARBAGE DESTRUCTOR.—N. FROST, care of Am. Foundry & Furnace Co., Bloomington, Ill. This apparatus is more especially designed for use in camps and other places having no sewers, and arranged to incinerate excreta and to evaporate urine, etc., and to destroy garbage or other loose material and to utilize the loose material as fuel for incinerating purposes.

OIL BURNER.—T. J. LANGSTON, Johnston, S. C. The principal object of the present invention is to provide a device by means of which oil such as kerosene may be vaporized and burned in a gaseous state. A further object of the invention is to provide a simple form of burner to be used in cooking and heating stoves, which is made up of pipes, elbows, T's, etc., of standard sizes and quality.

Household Utilities.

DUMB WAITER GUIDE.—W. F. KING, 46 Stuyvesant Place, New Brighton, N. Y., N. Y. This guide is made entirely of metal so as to comply with municipal ordinances relative to the exclusion of combustible materials from elevator or dumb waiter shafts. Means provide for anchoring the guides to the wall or walls whereby the guides may be easily adjusted to make them adapted for different constructions of elevator cars, and easier of installation than those now in common use.

Machines and Mechanical Devices.

FIRST COMBING MACHINE OF CARDING ENGINES.—T. F. POIRET, 40 Rue St. Denis, Paris, France. This invention relates to improvements in automatic unraveling conveyers for a wool-carding engine in which the wool to be carded, being placed in a trough, is seized by a toothed drum rotating in said trough and afterward evened upon the drum by a saw-toothed comb, having an oscillating motion tangent to the drum and acting alternately.

FRUIT DRIER.—L. B. SKINNER, Dunedin, Fla. This particular machine is adapted for drying oranges, grapefruit and the like, subsequent to the operation of washing them. In the machine small streams of air are forced directly upon the fruit, which is rotated so as to bring all parts into direct contact with the moving streams of air.

BENDING MACHINE.—F. T. ROOT and G. A. ENSIGN, care of Defiance Machine Works, Defiance, Ohio. The present invention is an improvement on patent No. 603,926. Its object is to provide an improved wood bending machine arranged to insure positive movement on the bending arms to cause the timber to hug the form snugly and thus produce accurate bending of the timber.

TAPPING MACHINE.—M. J. FORD, 125 10th St., Scranton, Pa. The machine provides a means for quickly forcing a tap into a hole and as quickly unscrewing it. It consists of a casing provided with a suitable handle, in which is a step-down gearing connecting a motor with the handle that receives the tapper member in which the tap is mounted. The motor is preferably of the pneumatic type.

MILL.—I. C. LANDES and M. C. LANDES, care of Landes Mill Works, Yerkes, Pa. The purpose here is to provide a mill in which the material entering the mill is caught by an auger having openings, the material being caught by the blade on the auger, and being forced by the auger into a recess formed by a disk and the casing of the mill, where the rotation of the material is retarded by radical stops, while the blades of the auger act on the middlings to break it up, so that it may be bolted through bolting cloth.

OPERATING MECHANISM FOR FLUSHING DEVICES.—O. KRETER and G. E. KRETER, care of Kreter & Son, 616½ Market St., San Antonio, Texas. This invention relates more particularly to the combination of an actuating member adapted to be operatively associated with a flushing device and with water closets and the like, an operating member tending to maintain a normal position and adapted to be actuated by a closet seat, and a dog operable by the seat and adapted to engage said actuating member during a predetermined part of its movement.

PNEUMATIC ACTION.—C. ALTER, 500 E. 83rd St., Manhattan, N. Y., N. Y. The invention pertains to piano players, player pianos and like instruments having pneumatics, and the object is to provide pneumatic action, which is exceedingly sensitive and insures a quick deflating and refilling of the pneumatic and thus allows sounding of the same note in quick succession.

GATE CONTROLLING MEANS.—A. E. GILES, 632 Brinker Ave., Latrobe, Pa. This invention provides for automatically locking the gate when the cage has been brought to the proper position at a landing, automatically holding the gate open so long as the cage remains in the predetermined position, and for automatically releasing the gate and causing it to close when the cage is moved above or below the landing or other predetermined point.

LOGGING JACK.—C. D. MOORE, Kirkland, Wash. In this jack a rack-bar is raised by means of a pivoted lever provided with a pawl adapted to engage a rotatable ratchet connected with the said rack-bar through the medium of a pinion. The objects of the invention are to simplify the construction, reduce the cost, lessen the friction, and increase power, speed, and efficiency of the jack.

CROWN PRINTING DEVICE.—W. JACKSON, care of the Robert Graves Co., 3rd Ave. & 35th St., Brooklyn, N. Y. In this invention use is made of an impression cylinder and a crown-printing roll mounted to rotate in unison with the said cylinder and having periodical bodily movement toward and from the peripheral face of the impression cylinder, to provide the wall paper passing round the said cylinder with crown imprints at desired intervals.

Railways and Their Accessories.

CAR DOOR.—S. WALTERS, 317 Morrison St., Warren, Pa. The principal object here is to provide a door embodying means whereby the door when in closed position will lie flush with the side of the cars, means being provided for moving the door preparatory to opening it, suitable rails being provided whereby the door may be rolled to uncover the opening, the door moving into a position remote from the side of the door.

Pertaining to Vehicles.

BUGGY SHAFT SUPPORT.—B. M. PURDUE, Franklin, Ky. An attachment for buggies is here provided which is adapted to support shafts or thills in raised position when the vehicle is not in use. The device consists of a spring actuated hook fixed to the buggy front and adapted to engage with the cross bar on the shaft.

BRAKE MECHANISM FOR AUTOMOBILES.—R. S. PELTON, Monticello, New York. This invention provides separate and independent brakes for the rear driving wheels of the automobile so that either wheel may be locked when it is desired to prevent its slipping in the mud, the propulsive effect of the motor being in such case applied to the other wheel resting on dry ground.

SHOCK ABSORBER.—W. H. BELL, 272 W. 139th St., Manhattan, N. Y., N. Y. This inventor provides means for checking the free operation of the carrying springs of a vehicle when acted upon by the irregularities of the road; provides for simplifying and economizing the construction; and provides an absorber shaped to vary the operation in accordance with the degree of vibration.

VEHICLE TIRE.—H. L. BIENER, care of J. S. SCHUSTER, 288 E. 157th St., N. Y., N. Y. This invention relates to vehicle tires such as shown in Letters Patent No. 571,945 formerly filed by Mr. Biener. The present invention provides a tire for wheels of automobiles and other vehicles, and arranged to provide the desired cushioning effect, without use of inflatable tubes, to render the tire puncture-proof and to permit of quickly making repairs when necessary.

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

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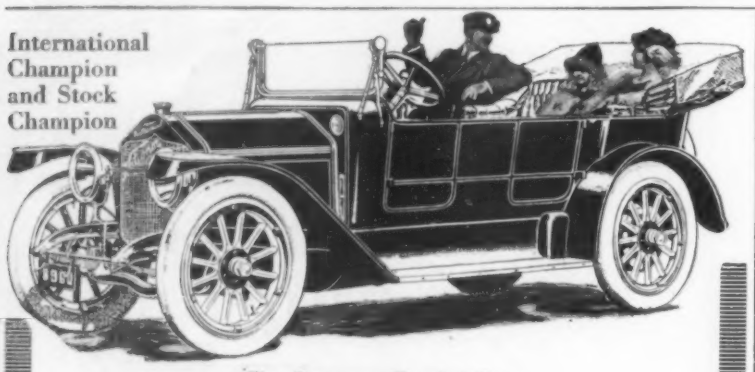

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Scientific American Supplement 470 describes the Harrington Rotary Engine, a form of intermittent gear.

Scientific American Supplement 497 describes Fielding & Platt's Universal-joint Rotary Engine.

Scientific American Supplement 507 describes the Jacomy Engine, a square-piston type.

Scientific American Supplement 528 describes Inclined-shaft Rotary Engine, using the universal-joint principle.

Scientific American Supplement 558 describes the Kingdon Engine, a "wabble-disk" design.

Scientific American Supplement 636 describes Riggs' Revolving-cylinder Engine, suggesting the present Gnome motor.

Scientific American Supplement 775 describes Revolving-cylinder engines of several forms.

Scientific American Supplement 1109-1110-1111 contains a series of great interest, describing and illustrating all the principal types of rotary engines and pumps. This set should be studied by every inventor and designer.

Scientific American Supplement 1112 describes the Filtz Rotary Motor, using helical surfaces.

Scientific American Supplement 1158 describes Hult's Rotary Engine, an eccentric-ring type.

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Scientific American Supplement 1309 describes The Colwell Rotary Engine, in which a piston travels entirely around an annular cylinder.

Scientific American Supplement 1524 describes Rotary Engine on the intermittent-gear principle.

Scientific American Supplement 1534 contains a valuable column on the difficulties of rotary engine design.

Scientific American Supplement 1821 contains an article describing many new forms of rotary engines of the most modern design.

Scientific American, No. 23, Vol. 102 contains a full description of the recent Herrick Rotary Engine, an eccentric type with swinging abutment.

Scientific American, No. 23, Vol. 104 describes Jarman's Engine, on the sliding-valve principle.

Scientific American, No. 14, Vol. 106 describes the Augustine Rotary Engine, with novel features incorporated in the sliding-valve design.

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The Evolution of Worlds

The Work of Sir George Howard Darwin

By John W. N. Sullivan

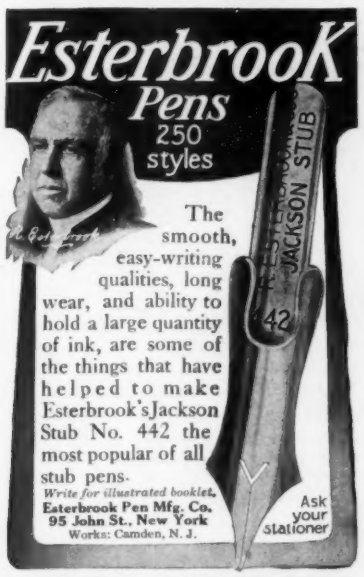
THE great conceptions of science have always possessed a more than scientific interest. The Copernican theory in astronomy, important as it was from the purely scientific point of view, was of still greater importance as a powerful factor in freeing men's minds from that local and narrow view which considered our planet to be the center of the universe, and all the starry hosts of heaven to be somewhat in the nature of pleasing ornaments. The Newtonian theory of gravitation, also, by showing that one great law reigned throughout the solar system, gave a unity to nature of the greatest philosophical and religious significance. And in our own time the theory of evolution, introduced as a hypothesis in the realm of biology, has influenced our conceptions in nearly every branch of knowledge.

One of the most fascinating illustrations of the general principle of evolution is found in the history of the origin and growth of the members of our solar system. It is fitting that the son of the man who told us so much about the origin of species should be the man to tell us so much about the origin of worlds.

George Howard Darwin, the second son of Charles Darwin, was born at Down in 1845 and died at Cambridge on December 7th, 1912. As a student he gained high mathematical honors at Cambridge, that breeding place of great mathematicians, and became Plumian professor of astronomy in the University in 1883. His interests embraced economic and political science, besides purely mathematical subjects, and he was, in fact, called to the bar in 1874. Considerations of health, however, led him to return to Cambridge. His greatest achievements have grown out of his interest in the theory of the tides. Newton was the first to give anything like a scientific explanation of their occurrence, and he gave a satisfactory account of the main features of the phenomena. The principles of further developments were laid down by Laplace and were afterward applied in a magnificent manner by Kelvin. It was at this point that George Darwin took up the subject, and the patience and tenacity he showed in performing vast and intricate numerical computations reminds one singularly of the same qualities shown by his father in collecting data for his theory of biological evolution. The main lines of tidal theory are well known. Most people are aware of the fact that the attraction of the moon and of the sun causes a kind of hump in the sea which travels round the earth owing to its rotation. The moon is the more powerful agent, and the two humps it produces (one on the side of the earth nearest the moon and the other on the opposite side) travel round the earth in about 24 hours 50 minutes, whereas the humps caused by the sun travel round in 24 hours. When the lunar and solar tides coincide we have spring tides, and when they act against one another we have neap tides. Such, in brief, is the main outline of the subject, but to pursue it into its details requires a vast amount of complicated mathematical analysis. But apart from the details of the actual tides experienced on our earth, they have a significance of far greater interest than themselves. They throw light on the origin of some members of our solar system. The tides do work—sometimes useful work, as in scooping out convenient landing places for our great ships, and sometimes useless work. But in any case the dissipation of energy is involved, and as we know that energy cannot be created, the question arises, where does it come from? The earth possesses a large store of energy in virtue of its revolution, and ultimately the energy daily expended by the tides must come from that. But the earth's store of energy, though great, is not infinite, and it must follow that the earth's store is decreasing, in other words, that the earth is slowing down in its revolutions. Of course, this slowing down is excessively minute, nevertheless it exists, and it follows that in ages long past the earth must have been rotating appreciably faster than at present. As we trace things back farther and farther we find the earth rotating faster and faster, and so the length of the day becoming continually less. Is there any limit to this process? The answer is that there is a certain critical velocity at which the materials composing the earth would be unable to resist the strain consequent on the velocity of rotation, and the earth would fly in pieces. This critical velocity has been calculated, and it appears that the length of a day in those inconceivably distant ages would be between three and four hours.

The length of our present day of twenty-four hours we have attributed to the action of the moon. The tides caused by the moon act as a kind of brake on the earth. But Newton's third law of motion teaches us that every action has its equal and opposite reaction. What has been the reaction of the earth on the moon? *The earth has driven the moon farther and farther away.* The principle of the conservation of the moment of momentum teaches us that the momentum lost in one part of the system must be gained in another, and, therefore, as the earth slows down the orbit of the moon becomes larger. The length of the day is increasing and so is the length of the month. In remote ages, when the earth was rotating much faster than it is now, the moon was much nearer than it is now. The relation between the velocity of rotation of the earth and the distance of the moon has been calculated, and we reach the enormously interesting result that at the time when the earth was rotating with the critical velocity of between three and four hours, the moon was at such a distance that it was just grazing the surface of our planet. This cannot be a mere coincidence. We are irresistibly impelled to the conclusion that we have reached the time of the birth of the moon. In that remote age the earth *did* fly in pieces. It broke up into two great lumps, and one of those lumps was the moon. At that time the length of the day and the length of the month were equal. Since then the earth has been driving the moon away, and the moon has been slowing down the earth. But the ratio of the month to the day has not been steadily increasing. It is true that it increased to a certain point, but then it started to decrease. Long before the dawn of history, perhaps before the appearance of men on this planet, there were more days in the month than there are now. At the period of maximum there were twenty-nine days in the month, or in other words, the earth completed twenty-nine revolutions on its axis while the moon completed one revolution round the earth. Since then the ratio of the month to the day has become steadily less. This process will only cease when the tides cease to act as a brake. This can only be when the earth rotates in the same time as the moon, so that once again the day will be as long as the month. So far as the earth-moon system is concerned, this condition will be dynamically stable. Having once been attained it will never alter. It has already been attained by the moon itself. It is well known that we only see one side of the moon, which means that the moon rotates on its axis in the same time in which it rotates round the earth. The earth-caused tides on the moon have done their work. If in that far-distant future any considerable part of the earth is still fluid, the solar tides may cause a still greater increase in the length of the day, and it may be that instead of the day being equal to the month, finality will be reached with a day longer than the month. This is what seems to have happened with the planet Mars.

Mars is probably older than the earth, and it is considerably smaller, so that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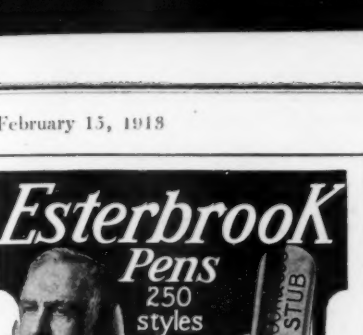
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tidal action should have already accomplished there what still lies in the distant future for our earth. Now one of the most astonishing things attending the discovery of the satellites of Mars in 1877 is the fact that the interior satellite Phobos revolves around Mars in 7 hours 39 minutes, while Mars revolves on its axis in 24 hours 37 minutes. There can be little doubt that this result is a direct consequence of the action of the solar tides on Mars, and is, as it were, an experimental verification of the mathematical predictions sketched above.

This necessarily brief and imperfect account of some of the most important work of the late George Darwin may serve to give the reader some idea of the magnitude of the problems which engrossed him and of the far-reaching importance of the results to which his genius led him.

His results aroused the interest of many other mathematicians, particularly the late Henri Poincaré, and there is no fear but that the subject will continue to receive the attention its importance warrants, although the inspiration to conceive, the stubborn patience to grapple with all difficulties, and the magnificent ability to overcome them, is hardly likely to be greater in his successors than it was in the great Englishman who has so lately vanished forever from among us.

A $100,000 Prize for a Gasoline Substitute

By Stanley Petman, M.E.

FOR years it has been prognosticated that the supply of gasoline eventually must prove inadequate to keep step with the demand. Lately, developments would seem to indicate that there has been more than a grain of truth and true prophecy in the forecast, for with the production of motor cars steadily increasing, at a rate that in not a few circles is viewed as alarming, the best efforts of the oil producers apparently are unavailing to meet the requirements.

At least, the price of fuel for automobiles steadily has soared—in a little more than one year it has gone up 88.8 per cent in America by leaps and bounds—and whether or not the true reason for the rise in price is good old "supply and demand," as so glibly is set forth by the oil barons themselves, the ultimate result is the same, i. e., the automobile owner must bear the burden.

That such conditions could not be allowed to endure long has been evident, for no man will stand idly by with folded hands when there is the ghost of a chance of ameliorating affairs. But the amelioration naturally will require the expenditure of much money and the devotion of much time to be effected. Within the past few weeks, the British Society of Motor Manufacturers and Traders has offered a prize of $100,000 for a fuel which may be used instead of "petrol," as gasoline is styled abroad. For some time, foreign motorists have used benzol, which is a coal tar derivative, as a substitute, but realization of its value has resulted in its price being boosted almost to that of gasoline. Added to which, it is procurable only in limited quantities as compared with the supply of gasoline.

All of which emphasizes very strongly the necessity for some sort of concerted action to relieve the situation, which rapidly is reaching the state where it is unbearable to motorists, who carry the heavy end of the load, and to every one else who uses internal combustion engines operating on the lighter distillates of petroleum.

At last, however, the International Association of Recognized Automobile Clubs, the membership of which is composed of representatives from the most influential automobile clubs throughout the world, has seen the light of necessity and has stepped into the breach by offering to finance the donation of a cash prize of $100,000 for the best all around fuel other than "petrol," or gasoline, which will satisfactorily take the place of the petroleum product.

The decision to offer the prize was made at the last meeting of the association,

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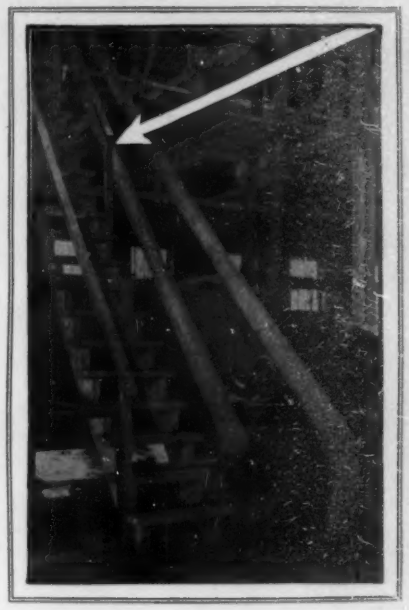

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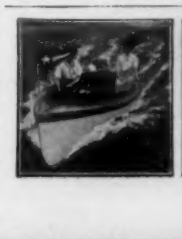

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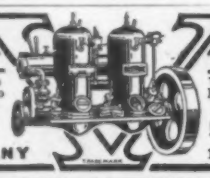

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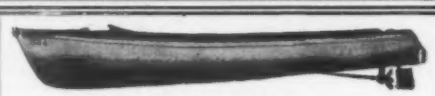

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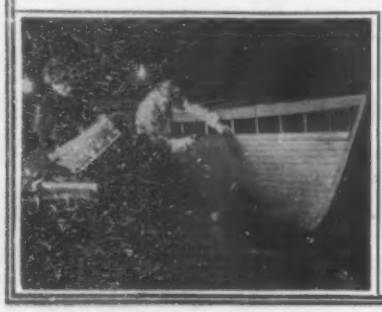

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which was held last month in Paris when it was arranged that each of the big clubs, in the organization, representing France, Great Britain, America, Germany, Belgium, Italy, Sweden, Denmark, Austria, Holland, Hungary, Russia, Switzerland, Roumania, and Egypt, should subscribe its portion to a general fund which shall constitute the prize. A special organization committee already has been named to go ahead with the work. Baron de Kuylen de Nyvelt is chairman and makes his headquarters at the offices of the International Association of Recognized Automobile Clubs in Paris.

As regards the contest itself, the restrictions are very simple: The fuel must be suitable for existing internal combustion engines; it must be less expensive, of course; it must be readily procurable; it must be of such nature that it cannot be "cornered" by trusts, national or international. That is all.

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A Comparison Microscope

(*Concluded from page 158.*)

highly advantageous to be able to compare directly under the microscope a specimen of the suspected article with a specimen of the same food-stuff of unquestioned purity.

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The pinions *A A* serve for the rough, and the micrometer screw *B* for the fine focussing of the microscopes, any difference in the thickness of the objects or their carriers being compensated by means of the screws *C C*.

The two prisms beneath the eye-piece are mounted on a slider, which can be moved to right or left by turning the pinion *D*, so that the field of view can be occupied entirely by either of the microscopic preparations, or divided equally between the two. The median position of the prisms is marked and maintained.

The instrument, therefore, is virtually equivalent to two microscopes of the ordinary type, but it possesses the additional and important advantage that the two objects under observation can easily and instantly be brought into the same field of view for close comparison.

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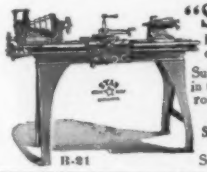
The Current Supplement

IN the current issue, No. 1937, of our SUPPLEMENT, W. Rosenhain concludes his article on Alloys Suitable for Instrument Work.—Dr. J. E. Teeple writes on Wood Waste Utilization.—Some extensive river improvements on the Missouri, in which concrete piles have been used, are described in an illustrated article.—Jean Dawson reports on the campaign against flies which the city of Cleveland has been waging with much determination.—Messrs. Ellis and Dray describe a system whereby oils can be used in the ordinary type of gas engine.—Prof. Runge writes on the Significance of Spectroscopy for the Atomic Theory.—Prof. Foley describes a remarkably elegant method of photographing sound waves.



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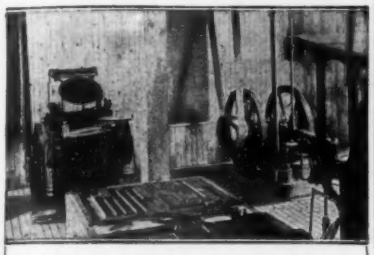

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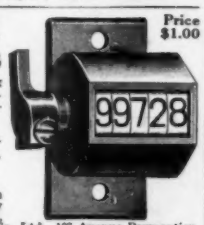

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(12744) J. A. J. H. asks: From time to time in houses I have seen "weather glasses," not of the mercury or aneroid classes. In appearance these consist of a large-size test tube nearly filled with a pale yellow liquid with some white feathery substance floating in it. Can you tell me on what principle these predict unsettled weather? Do you know of a receipt for making up the contents of the tube? In your opinion, is this form of "barometer" (?) reliable? A. The so-called weather glass, or storm glass, is in no sense a barometer. It contains alcohol in which camphor and other substances have been put, a larger quantity than will remain in solution. The glass is then sealed. No effect of air pressure can reach the liquid within the glass. There would seem to be no element of the weather excepting the temperature which can affect the liquid in the tube. It is not possible that moisture should produce any change in the amount of camphor dissolved in the alcohol, nor that this instrument should foretell the coming on of a storm. A recipe given in the "Scientific American Cyclopedia of Formulas," price $5, is as follows: 10 grammes of camphor, 5 grammes of saltpeter, 5 grammes of sal ammoniac, 105 grammes of 90 per cent alcohol, 45 grammes of water, dissolved together.

(12745) J. F. asks: Can you tell me through your correspondence page which is the heavier—moisture or air? If this query is too general in character, I can put it this way: In discussing the reason for the excessive dryness of cigars kept in a case in which the moisture is supplied by a cylindrical device containing water, which is suspended in the top of the case, the point was raised that the moisture would reach the tobacco more effectively if the water was at the bottom, as the moisture or vapor evolved by evaporation would rise rather than fall. This led to a general discussion as to whether moisture or air, as a general proposition, is the heavier. A. Water vapor is about five eighths as heavy as air at the same temperature and pressure. This however does not decide the question you propound, because moisture will diffuse throughout any space in which it is, up or down, whether the water is at the bottom or at the top. All gases thus diffuse somewhat rapidly.

(12746) C. M. M. asks: Will you kindly publish in the query column some explanation of the condition existing in many people, myself in particular, of what is commonly termed "getting turned around," or in other words, losing the cardinal points of the compass when traveling away from home. I have in mind certain conditions in various cities under which it seems absolutely impossible to realize north as being in its proper place, even though I know it to be so. A. The fact is that every man is peculiar in certain points and to different degrees. One man has an acute sense of direction, so that he can tell the north and south direction in almost any place; another is, as you express it, "turned around" very easily and cannot tell the direction in which he should go on coming out of a door upon a city street. It may be a dullness of sense perception, and it may be that the man has not tried to educate his sense of direction. It seems to be an individual peculiarity, just as many other matters of sense and disposition are peculiar to an individual, and constitute the individuality of the person.

(12747) C. F. S. asks: I have been using an aluminium vessel partly filled with water in which a little baking soda has been placed for boiling silver ware in order to brighten and polish the silver ware. I had read the directions in a newspaper and tried the process with good results. Would you kindly advise the chemical or physical principle by which the cleaning and polishing or brightening is done? Is it injurious to the silverware? A. The process you describe for cleaning silver is mostly electrical, or electrolytic, the current between the silver and aluminium taking off an extremely thin layer of silver and leaving the ware clean. Probably no more silver, if as much, is removed at each cleaning than would be removed by polishing with an abrasive silver polish.

(12748) J. W. G. asks: 1. A question in physics is under discussion. What is the lowest temperature that ice can register? I am informed that 29 1/5 deg. Fahr. is the lowest. A. After water has frozen, the ice is a solid and may be cooled to any degree below freezing, just as any other stone may be. It cannot be heated above 32 deg. Fahr., which is the freezing point of water and the melting point of ice. 2. What is the reason that the heat is not lowered when ice is formed in a freezing mixture of say minus 200 deg. Cent.? A. When water freezes it gives off heat, which tends to warm the surrounding air, and cannot cool it as you seem to suppose. In a freezing mixture the ice is melted, and the heat necessary to melt the ice is taken out of the substance which is to be frozen, as in making ice cream. 3. Is ice a practical insulator at low temperature, and why? A. In a sense ice might be called an insulator for heat, but the heat of the sun passes readily through it and may be felt on the other side of the ice. A piece of ice may be made into a lens and the heat of the sun focused by it so that it would burn the skin.

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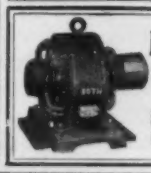

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